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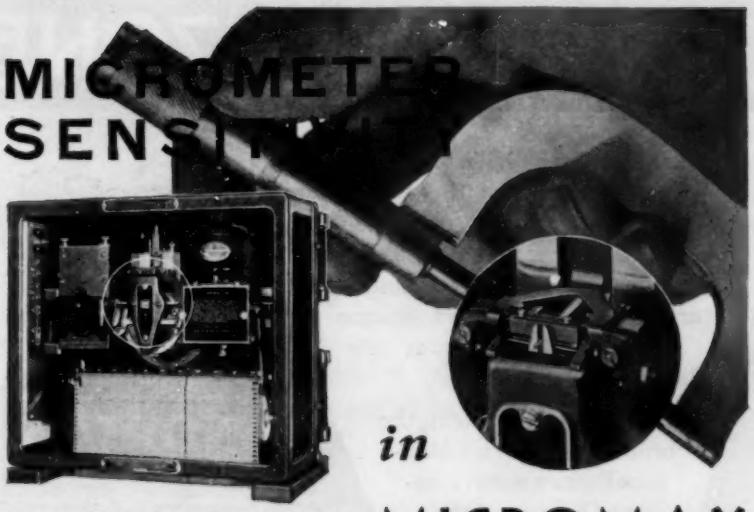

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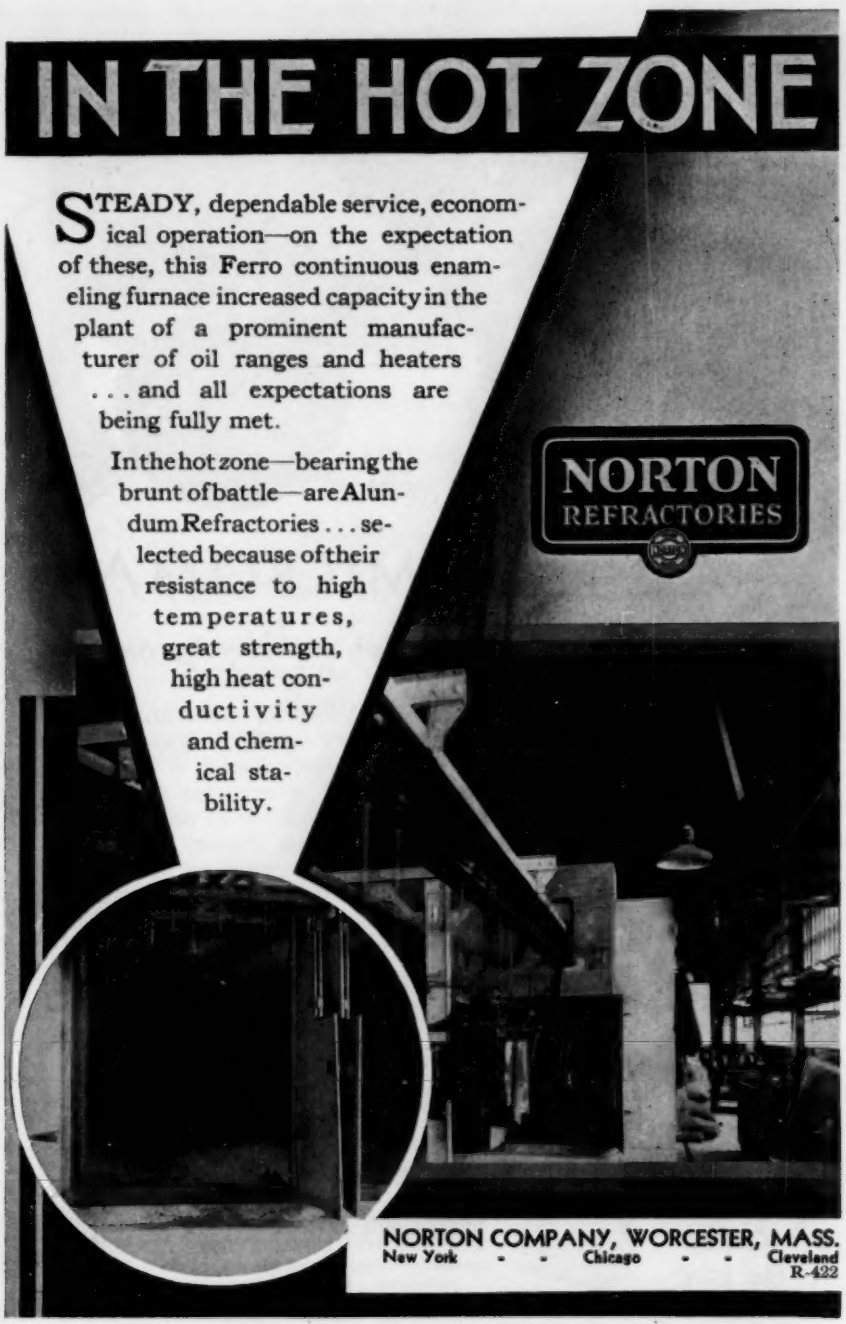

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DEGASSING CLAYS BEFORE MOLDING[1]

By H. R. Straight and M. G. Cowman

ABSTRACT

The value of a degassing rotary soak table is shown in decreased laminations and greater adhesion of the clay grains. The clay must be ground sufficiently fine to degas the particles quickly.

I. Introduction

A discussion is presented of the processing of fire clays and shales as compared to the loess or débris types of material on account of their widely different nature. For simplicity, both the fire clays and the shales will be referred to as clays.

A study was made of the following effects in the degassing process: (1) grinding or the reduction to the natural grain, (2) pugging, in which the water of plasticity is added, and (3) evacuating the gases prior to molding.

These tests were made to determine how certain mechanical changes in processes have been made to aid in accomplishing the separation of the combined gases and entrapped air before the clay passes through the die in its final molded form.

II. Grinding

The widely used dry pan runs with a depth of one to three or more inches of material being ground under the mullers. This depth of material serves to cushion the pressure, permitting the pressure to be distributed over the entire width of the muller face and for some distance on each side of the theoretical contact under the face. Mullers that weigh three tons with a 12-inch face will exert approximately 300 pounds per square inch maximum on the material. This pressure does not break down to the initial grain the natural cemented condition of the clay particles with dry-pan crushing and the result is that many particles of the clay pass through the entire process without being reduced to their initial grain size. Such grinding does not produce as favorable results in securing maximum plasticity as where the grain is broken down completely.

In order to accomplish this kind of grinding, a heavy-duty rock crusher was installed through which, between the two smooth rolls running at the same speed, the clay was given one pass only. The rolls are fed uniformly from side to side across their comparatively narrow faces so that the wear of the faces is uniform and little roll grinding is necessary to maintain uniform clearances. The pressure exerted on an almost line contact is very high, being approximately 5000 lb. per linear inch of face and with little clay being worked on at high speed, the maximum pressure probably runs

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Structural Clay Products Division).

to nearly 50,000 lb. per linear inch. This pressure is so great that the natural cemented structure of the grains is almost completely broken down. The pressure exerted is sufficient to roll out a steel nut. The flakes that come through appear to be very hard but it is found that these flakes dissolve completely and quickly into a putty upon contact with water. It is well known that the grains of the clay from dry-pan grinding dissolve slowly, if at all.

This step in the preparation is very important. Unless the water can work quickly and uniformly on the ground clay during the pugging, it cannot easily and uniformly surround the grains of the clay material and the physical action between the clay and the water cannot take place

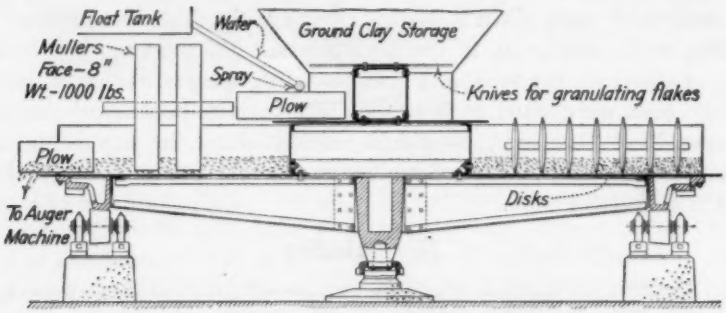

FIG. 1.—Diagrammatic view of rotary soak table.

quickly. The upkeep of such a roll crusher is much less than the upkeep of the dry pan. The added power required by such a clay crusher is enough greater to offset any saving in the cost of grinding, but the advantages later secured in processing make such a method well worth considering.

III. Pugging

The old-fashioned soak pit gave a degree of plasticity and a final structure in a molded unit that cannot otherwise be obtained. The wet pan approaches the results of the soak pit. With the idea of combining these two, a special machine was designed for a continuous processing of the clay while being pugged, at the same time prolonging the soaking after the water is applied. In this way time is allowed for slaking to take place.

Laboratory research showed that slaking had taken place almost completely by the end of eight minutes, and the combined gases had been almost entirely freed from the clay particles. The following tabulated results[2] give the increase in pressure due to the action of the water and the clay and the volume of gas given off from 25 grams of clay.

The action of the clay in water has been little recognized until recently,

[2] Made by M. G. Cowman, Iowa State College, Ames, Iowa.

but there can be little doubt that a clay that is quickly pugged and molded is not given time to allow the gases to be unlocked and freed from the clay until after the molding has been completed. The result must be some blisters and lamination that cannot be laid to entrapped air.

These gases are shown by an analysis to be largely hydrocarbons, formed no doubt by the decomposition of vegetable matter laid down with the

TABLE I

List No.	Owner and location	Pressure H_2O (cm.)	Volume of 25 grams (cc.)	Air by volume (%)	Remarks
1	A. P. Green Firebrick Co., Mexico, Mo.	0.32	10.2	3.14	Apparently some "heat of wetting" for pressure; went to 0.6 at first
2	A. C. Ochs Co., Springfield, Minn.	0.62	12.0	5.17	Clay in leather-hard state when received; dried samples gave same results
3	Gladding, McBean & Co., Los Angeles, Calif.	0.58	9.6	6.04	Mix of 2/3 siliceous loam, 1/3 plastic red; bad lamination
4a	Rockford Co., Rockford, Iowa	0.50	10.2	4.90	Coarse ground clay from bin; slaked quickly, constant pressure in 45 min.
4b	Rockford Co., Rockford, Iowa	0.31	9.7	3.20	Fine ground, mortar mix, slaked as above
5	Sequin, B. & T., Co., McQueeny, Texas	0.41	10.5	3.90	From face having 2- to 15-ft. seams blue clay and 1- to 15-ft. seams yellow clay, separated by sand seams
6	Ohio Clay Co., Cleveland, Ohio	0.22	9.8	2.25	Slaked slowly
7	Black Hills Clay Products Co., Belle Fourche, S. D.	0.75	10.1	7.42	Probably contains bentonite
8	Humbolt B. & T. Co., Humbolt, Kans.	0.40	9.4	4.26	Very hard, slow slaking
9	Yankee Hill Co., Lincoln, Nebr.	0.80	10.9	8.08	Looked flintlike, but slaked easily; constant pressure in 45 min.
10a	Vulcan B. & T., Birmingham, Ala.	1.00	9.6	10.4	Used to make hollow tile
10b	Vulcan B. & T., Birmingham, Ala.	1.04	9.7	10.7	Part 10a, used for southern section
11	Natl. Fireproofing Co., East Canton, Ohio	0.46	10.0	4.6	Slow and difficult to slake
12	Indiana Tile, Brooklyn, Ind.	0.16	9.8	1.63	Previously slaked
13	Columbus B. & T., Daisy, Tenn.	0.43	9.9	4.34	Clay from 100-ft. face, slaked in 45 min.
14	Acme Co., Ft. Worth, Tex.	0.52	10.1	5.15	Slaked very slowly, gases evolved for 1 hr. and 15 min.
15	Alberta Clay Products Co., Alberta, Can.	0.52	10.4	5.20	Seemed very plastic, with mechanical aid required 2 hr. to slake
16a	Adel Clay Products Co., Redfield, Iowa	0.18	10.2	1.76	Previously slaked
16b	Adel Clay Products Co., Redfield, Iowa	0.68	10.0	6.80	Sack ground from bin
17	United Clay Products Co., Adel, Iowa	0.41	10.3	3.99	Slaking time 1 hr. to reach constant pressure

clay substances. The gases are held during the hardening of the clay mass in the deposit in intimate contact by the pressure built up in the close-grained deposit by the decomposition and finally are absorbed into the clay body and locked so securely that exposure to air alone does not allow them to escape except after considerable weathering or upon the application of water.

The physical action with water known as hydrolysis is set up after a varying time interval. In most clays the action starts in three to four minutes and is approximately complete within twelve minutes. This varies in all clays for no two are laid down under exactly the same condition.

It is well to repeat here that unless the structure of the clay has been broken down to the original grain size the water cannot penetrate freely and hydrolysis cannot be completed within the allowed time in the process before the unit has been molded. Therefore, if the grain structure is not reduced or the time interval is not sufficient to allow the action to be approximately complete before molding, it is easily seen that blistering of a molded unit must be partly caused from gases evolved after the material finally passes from the die.

IV. Molding

Molding to a shape with the ordinary machinery in general use is sure to trap considerable amounts of gases and air which will collect in various parts of the unit and more particularly between the layers at the end of the auger leaves or blades where it is laid in between the layers of clay discharged from the auger. The square ends of the auger leaves or blades act much like the pistons on a vacuum pump and actually suck the air from the clay and cause accumulation of air at the end of the leaves where it is laid in between the layers of clay. The smooth surfaces of the clay just having passed over the auger with the fine particles of clay substance sucked or worked for the surface act as a check valve and prevent the air from being squeezed back into the clay body. The resulting accumulation of air or gas results in what is known as auger lamination. Usually the more plastic the clay the more severe is the lamination, for the finer the grain of the clay the more the air is retarded from being pressed back into the clay beyond the surfaces smoothed by the augers.

V. Conclusion

It is apparent that auger lamination can be decreased in four ways, (1) by grinding the clay to break down the natural cemented structure of grains, (2) by soaking until the gases are released, (3) by evacuating the air from the clay used, and (4) by streamlining the discharge ends of the augers so that the displacement due to the thickness of the leaves will be gradually relieved as the clay is discharged from the auger and a suction

cannot be set up on the clay. A special auger machine has accomplished much in evacuating the gases under a partial vacuum. Work is now in progress in streamlining the auger discharge ends.

There is no real reason why clay particles in the absence of air or gases will not properly unite under pressure. H. Spurrier[3] proved in his classical experiment on the hollow clay box placed under a vacuum and then subjected to an impact that it would collapse so completely that no evidence of a hole could be found inside. Therefore, the proper removal of gases will result in a molded body from an auger machine in which little or no lamination will be evident, but hydrolysis must be complete before even a vacuum can be effective.

ADEL CLAY PRODUCTS COMPANY
ADEL, IOWA

[3] *Jour. Amer. Ceram. Soc.*, 9 [8], 535 (1926).

A COMPARATIVE STUDY SHOWING THE POSSIBILITIES OF SILLIMANITE FOR USE IN EXTRUSION DIES[1]

By P. W. Dagger and A. G. Betteley

ABSTRACT

This article sets forth the results obtained on the use of sillimanite for extrusion dies. A comparison of the relative length of life of various metal dies and sillimanite dies shows that sillimanite is very resistant to abrasion and has possibilities for use in dies.

I. Introduction

Extrusion of plastic columns involves the problem of obtaining suitable dies. Having obtained the correct design, the next problem is to make the dies from abrasion-resistant material. Some materials extruded are much less abrasive than others, but the abrading action of ceramic bodies is usually great. For forming of spark plug blanks, a number of tests have been made on the relative merits of cold-rolled steel, annealed steels, bronze, and sillimanite. Sillimanite dies proved to be superior in these tests.

Dies made years ago from porcelain were not successful. Later, sillimanite was used to make taps for putting threads in dried ceramic ware and proved to have a much longer life than steel, sillimanite taps giving 3000 cores per tap and steel taps giving 300 cores per tap.

It has also proved possible to make dies from sillimanite. At present all of the pug mills used at the Champion Porcelain Company in the production of the spark plug blanks are equipped with sillimanite dies.

II. Abrasion Tests of Die Materials

The tests on the relative length of life of dies from the various materials were made by keeping a record of performance in a regular production pug mill. All of the dies and all of the pug mills used were of the same design. Figure 1 shows the set-up of a pug mill; Fig. 2 is that of a sillimanite die.

A one-inch column of body flowed through the dies at the rate of about 20 feet per minute, or approximately 10,000 feet of body per day. The body was very short and high in nonplastics where their fineness was greater than 325-mesh. When a poor column was produced due to the die, *i.e.*, an imperfection developed in the die that affected the column, or the oversize limit of 0.020 inch was reached, the die was considered worn out and its test completed.

(1). Cold-Rolled Steel The average life obtained was 5 to 6 working days with a maximum life of 10 working days and a minimum of 3 dies in one working day.

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (White Wares Division). Revised copy received April 22, 1931.

(2) Annealed Steel (*a*) Steel as received lasted 35 working days at which time it was 0.016 inch oversize. (*b*) Steel heated to 1050°F and quenched lasted 32 working days. (*c*) Steel heated to 1650°F and quenched lasted 34 working days.

(3) Very Hard Steel These dies had a very short life; one die lasted 1 hour, another $4^1/_2$ hours.

(4) Bronze (20 to 25% lead) Average 4 to $4^1/_2$ working days.

(5) Sillimanite Two dies were removed after 90 working days and one after 85 working days; all were giving good columns but the oversize limit of 0.020 inch had been reached.

FIG. 1.

The average life of the sillimanite dies is more than twice the life of the best metal die tested. After approximately 170 miles of pugged body had passed through the die opening the oversize was just 0.020 inch and the die was otherwise producing a good column of body.

III. Other Points of Comparison

(1) Quality of Column The quality of the column extruded through sillimanite dies is, without a doubt, better. In new and well-polished steel dies the columns extruded had a scaly appearance, seeming to be made up of a series of small cracks. The sillimanite dies give a smooth surface and in all cases are free from any trace of the scaly appearance.

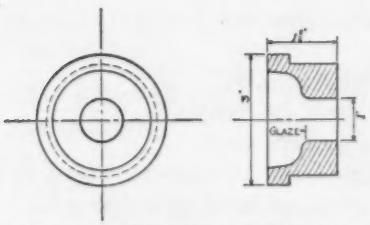

FIG. 2.—Sillimanite extrusion die.

(2) Wear of Die Edge The discharging edge of the steel dies becomes dull in use while the sillimanite dies sharpen noticeably. The explanation for this appears to be that the edges of the steel dies are weakened and chipped back by rusting. When the edge of a die is dulled the die is useless.

(3) Pressure Strength The sillimanite dies have sufficient structural strength to withstand the pressures exerted

on them. None of them have been broken or even cracked in service and they have now been in constant use in production on seven pug mills for nine months.

IV. Conclusion

The results obtained in actual use make it seem quite probable that sillimanite dies will find many applications. The remarkable abrasion-resisting qualities, the long service, and the production of good columns give sillimanite dies a decided value in the extrusion of plastic columns.

Acknowledgment The development of sillimanite extrusion dies has come about from a number of years of experimenting at the plant of the Champion Porcelain Company and does not represent the work of any single individual. The authors wish to express their thanks to the management for permission to publish this article.

CHAMPION PORCELAIN COMPANY
DETROIT, MICH.

NOTES ON DRYING AND DRIER OPERATION[1]

By James T. Robson

ABSTRACT

A brief résumé is given, comparing drying shrinkage with the action of clay slaking in a bank. The drying of Missouri dry-press refractories in summer versus winter and blistering and means of prevention are discussed. The operation of three Harrop type driers and an ordinary waste-heat tunnel drier are described.

I. Introduction

(1) Example from Clay Lumps

Drying of clayware may be compared to the well-known slaking of clay in a bank. When exposed to the weather, the clay loses its moisture rapidly. As it loses moisture there is a gradual drift of moisture from the interior to the exterior or surface. If the loss of moisture at the surface exceeds the rate at which it is replaced by water from the interior of the piece, there is a greater shrinkage of the clay at the surface as compared to the interior of the piece and stresses are generated in the surface of the clay. These stresses in the surface cause it to crack and disintegrate.

Likewise, when the air-dried clay is wetted by rain, the exposed surface of the clay gains moisture more rapidly than the interior of the piece, causing greater expansion in the surface clay and the clay breaks down further. As this process of drying and wetting is continued where the clay is exposed to the weather, the slaking proceeds and the exposed lumps of clay may disintegrate completely.

(2) Effect of Water Condensing

This is the same phenomenon that may take place when ware, especially dry press, is placed in a drier with high humidity, *i.e.*, humidity sufficiently high so that the cold ware coming in will cause the air to fall below its dew point or that point at which water condenses on to the ware. This condensation acts similarly to the example just cited where the outside surface absorbs the water, expands more than the inside or relatively dry portion, resulting in strains on the outside and causing cracks or sometimes crazing.

(3) Effect of Rapid Drying

Too rapid drying will also give a similar appearance. Just as cited in the clay bank, the water evaporates from the outside due to too intense heat or circulation at a rate considerably faster than it can be brought to the surface from the center or inside, resulting in shrinkage of the outside which is greater than that on the inside and hence strains are set up due to the outer layer or skin tightening up around the larger inside, similar to stretching a rubber band around some article. This is commonly known as "case hardening." If

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (White Wares Division).

this outside skin, or rubber-band equivalent, holds during shrinkage without cracking as the water from the inside comes out, it may have such a strong tendency to come out with too rapid drying that the sudden expansion or strains set up in the outside may cause it to crack or craze. Thus there may be the same appearance from condensation on the outside, when the material is charged into the drier, as is obtained when the material is dried too rapidly.

(4) Outside Skin Formed by Die

In the case of smooth-faced heavy clayware, the smooth tight outside skin formed by the die acts similarly to the rubber band. It must be strong enough so that it will not crack when initial drying takes place on the outside until the inside shrinks and relieves the strain or tension on the outside surface.

In the case of coarse-textured and open material where there is no tight or close-grained surface, not only are the pores or channels through the inside of the material open sufficiently to allow a rapid flow of moisture to the surface, but these pores are not closed at the surface by a tight covering or skin; consequently, the coarse-grained or open material is easier to dry without cracking, providing there is enough plasticity or cohesion of the particles to hold themselves together.

II. Drying Missouri Dry-Press Refractories

In the past, difficulty has been found with the Missouri clays during the winter time. This has been attributed mostly to frozen clay. In cases where there was no chance of frozen clay getting into the plant, however, the trouble still remained so that the cause had to be looked for elsewhere.

Heretofore blame has been placed on the kiln. At one of the Missouri plants the kiln was changed by running the charging end from the lowest limit to the highest limit in temperature with little or no difference on the final product. The results at this plant showed conclusively that the trouble was not with the kiln.

A car of dry brick was removed from the drier and torn down. Checking was found in the drier or ahead of the drier proving that it was not occurring in the kiln.

The drier temperature was about 220°F at the hot end which was the same temperature at which the drier was operated during the summer time. Therefore a thorough investigation was made of all conditions in the plant to find out some difference between the operation during the winter and the summer time when the results were satisfactory.

There was only one difference that could be noted. In the clay pit when a lump of clay was broken open it appeared damp throughout. This condition did not exist during the summer time. It was also noted that the

brick checked as they came from the press. By holding the water content between 7.0% and 7.5% on the dry-clay basis at the press, this checking could be overcome and also by maintaining the maximum temperature in the drier at 180°F, the brick came through the drier satisfactorily without checking.

The temperature conditions in the drier, which gave satisfactory results during the winter time, taken through windows on both the inlet and exhaust sides were as follows:

	Inlet side				Exhaust side				
Car lengths	1	9	15	26	4	12	19	23	31
Temperature (°F)	102	106	146	180	92	116	146	150	164

High humidity at the charging end of the drier was unnecessary as the best results were obtained with a humidity of 80% or lower. The temperature of the air in the exhaust stack was 92°.

A later test run with the drier set as above, but using a higher percentage of water in the clay at the press, again gave considerable checking so that both the water content and the drier temperature had to be watched carefully for proper control.

III. Blistering

When the ware containing air pockets near the surface, due to incomplete expulsion of the air from the clay column, is placed in a drier containing hot air, the air underneath the outside skin expands and causes it to swell or sometimes even disrupt or break. In such a case the tendency to form blisters is thus increased. Often blisters will form even though the temperature of drying is actually lower than the temperature of the column as it comes from the machine, *i.e.*, blisters which show up when the column or brick are left standing on the off-bearing belt. This can be due to the fact that the pressure of the air under the surface is so great that it stretches the clay skin itself, even though the actual temperature of the air may be decreasing, resulting in a slight decrease in volume of the air itself.

The outside of the ware may begin to dry and shrink at a rate much faster than the air decreases in volume due to lowering temperature, and the result is blistering.

Blistering can also be greatly increased even where the moisture or humidity of the air is high. The cold ware coming into the drier is sometimes below the dew point of the air therein and moisture is absorbed. This makes a soft or more flexible skin over the outside which expands with the air pressure inside, resulting in blistering.

The proper way to eliminate any tendency to blister is to prevent air from getting into the clay column before it passes through the die. One method of preventing this is to apply a vacuum to the clay before it enters the die.

Many devices and means have been tried for preventing lamination or

air pockets in the ware. Some of these are combination knives and augers, two- and three-wing propellers, slow operation of the auger to allow the air to escape, varying distances from auger to die by rings, changing taper of die and shape of die, substituting bronze for steel dies, varying temper of clay, weathering clay, keeping the machine well filled to exclude air, putting obstructions of various types at the die, *e.g.*, retarding bar and chain links, using steam for lubrication or in the clay, addition of common salt, epsom salt, calcium chloride, soda ash, and other chemicals to the clay, heavy rollers on the column, heated rollers on the column, and many other more or less successful means. The use of grog to open up such a clay will help.

Once blisters are formed, facing the ware one on top of the other will sometimes give enough weight so that the weight itself will counteract the effect of the air pressure inside the body. If this procedure is insufficient, the ware can be stacked one on top of the other; for instance, 6- by 6-inch quarry tile, thirty high or less, with a weight applied if necessary. This will force the blisters to come out on the back or underside where they are not objectionable in the case of thin ware, such as quarry tile.

Where the tendency to blister is not too great, often, by keeping the drier temperature low in the charging end or allowing the ware to stand outside or at room temperature for several hours, then proceeding at a normal drying rate, the air in the pockets will not exert sufficient pressure to blister the ware.

Laminations not only cause blistering but break up the continuity of the capillaries so that the passage of water is hindered and consequently the outer shell cracks, then the air enters the second cracks and begins to work on the surface of the second shell and the result again takes place as on the outer shell, etc., until the ware is a series of successive shells and is badly shattered.[2]

IV. Dry-Press Drier

For drying dry-press refractories, using a drier involving the patented Harrop alternate circular movement of air, by charging the cars into the drier at 100 to 110°F and holding below 120° for at least 6 hours, then advancing to 160 or 180° in 10 to 11 hours, and holding these temperatures for the remaining 7 or 8 hours, the brick are satisfactorily dried down to less than $^1/_2$% moisture.

In these cases of dry-press ware, it has been found that humidity has practically no helpful effect. The average inlet humidity is about 80%. This drops to about 60% at 12 car lengths and down to 40% at 19 car lengths. The temperature curve (Fig. 1), shows the temperature condition on the air-inlet side of this type of drier and gives satisfactory drying

[2] Ellis Lovejoy, "Clay-Worker," 1912.

results on 7 to 8% water content dry-press ware in 24 hours. The brick after leaving the drier average about 0.5% or less moisture content in the center bottom.

The air circulation in this type of drier is shown in Fig. 2. This was measured by an anemometer held at arm's length back in the setting with just enough space between cars to allow the operator to stand.

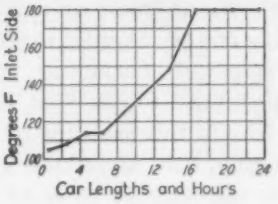

FIG. 1.

A center baffle is located every car and one-half length as shown at D. This increases the circulation at C_1 to 410 feet per minute and at C_2 to 230 feet per minute. At A_1 it decreases from 365 feet per minute to 315 feet per minute and at A_2 it decreases from 250 to 150 feet per minute. Below D the vertical downward flow is decreased from 1120 to 985 feet per minute. The direction of circulation is alternated at varying lengths through the drier. The average percentage of moisture in the middle of the setting under these conditions is 0.5% or less in 24 hours.

V. Preliminary Drier

For rapid drying of stiff-mud brick with Harrop alternate circular movement, a smaller drier is used. The brick are spaced about 1 inch apart by hacking onto decks one high, 60 brick per 5 decks, and 66 brick on the top deck, making a total of 366 brick per car. The inlet temperature at the hot end is 350°F and air at 300°F is admitted at a fan midway the length of the tunnel. At the charging end of the drier, the exhaust air is 120°F. These brick are cored with two $1^1/_2$-inch holes and a $^3/_4$-inch hole in the middle and contain about 15% water; a green brick averages 5 lb. 10 oz. and a dry brick 4 lb. 14 oz.

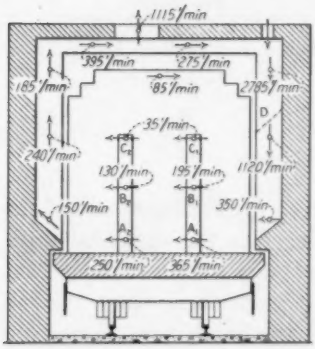

FIG. 2.—Air velocities with ware in drier. A, bottom brick; B, 5 brick high in flue; C, top of flue; D, side baffle.

By keeping these brick separated, using a high temperature and strong circulation, the brick are dried leather hard in 3 hours, whereupon they are set onto the kiln cars and run through the large drier for final drying. The inlet to the large drier is 120°F and the discharge end is 280°F.

These five tunnels were originally 85 feet long. Later they were increased 100 feet in length, making them 185 feet overall and practically

bone dry, an average of 12,000 brick per tunnel per 12 hours (or the brick are dried to 2% or less moisture in 6 hours).[3]

VI. Stiff-Mud Drier

On one type of stiff-mud drier, eight 100-foot tunnels are used. The Harrop alternate circular movement principle is used here also. The charging end of the drier is operated at 100°F and the discharge end at 250°F. To get 24-hour drying, it is necessary to raise the air supply temperature up to 300 to 350°F at night. If fresh-made brick were charged into the drier at this heat, the brick would not only blister badly but a center lamination core would also show up. This is prevented by allowing the cars to stand under cover at room temperature for about 8 to 9 hours, after which they are charged into the drier and dry thoroughly in the remaining 15 or 16 hours with safety, so that the cars introduced at 110° and withdrawn at 300 to 350°F dry satisfactorily in 24 hours' total time.

VII. Hollow Tile Waste-Heat Tunnel Drier

A certain hollow tile drier was not giving satisfactory results. It was of the waste-heat tunnel type of ordinary design in which air comes up through the floor and travels longitudinally down to the charging end where it is drawn out at the bottom. Examination showed the following conditions at the two ends.

	Entering air			Exhaust air		
Tunnel No.	Dry bulb (°F)	Wet bulb (°F)	Relative humidity (%)	Dry bulb (°F)	Wet bulb (°F)	Relative humidity (%)
1	132	106	42	85	85	100
29	164	112	19	78	78	"
42	162	120	31	82	82	"
45	158	126	40	80	80	"

These results show that the air was saturated at the discharge end of the drier. Inside the tunnels, the dry-bulb reading was the same for three car lengths back in the tunnel and the ware was very soggy, showing that condensation was taking place on the ware. Since these three cars of ware were receiving little or no heat and at the same time taking up moisture from the saturated air, more harm than good was being done to these entering cars so that the drier was being operated inefficiently. Instead of utilizing the full length of the tunnel and heating the ware gradually, at least three car lengths or 21 feet of the tunnel were being wasted.

The above readings were taken in the morning before starting the shift.

[3] Work done by C. L. Colbert.

The drier tunnels held 15 cars and were charged usually two at a time during the working shift. This caused a variation in the temperature and humidity curves at different hours of the day, so that for a comparison, it was necessary to take readings at the same time each day. To get satisfactory drying of tile up to 12 by 12 inches, the temperature curve (Fig. 3) was finally developed.

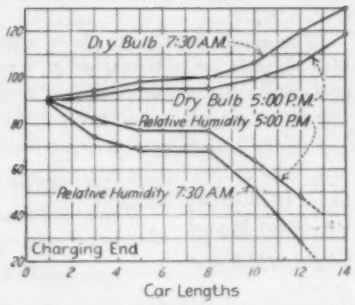

FIG. 3.—The ordinates should be labeled per cent relative humidity and dry-bulb temperature, °F.

The 5:00 P.M. reading gives the condition just after the tunnels are filled and the 7:30 A.M. reading gives the tunnel conditions after the ware has stood in the drier without moving over night. Here the average temperature, one car length inside the charging end, was 90°F (dry bulb) with 90% relative humidity. This humidity fell gradually for about eight car lengths to 70%, where it then fell rapidly and quick drying took place so that the tile could be dried safely in 48 hours.

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DIFFICULTIES IN FIRING WHITE WARE[1]

By James T. Robson

ABSTRACT

The causes and methods of overcoming various difficulties in the firing of both vitreous and semivitreous white ware are discussed, together with a method of easily observing craze marks produced in crazing tests.

I. Introduction

(1) Blistering on Vitrified Hotel Chinaware

In vitrified ware, it is essential to fire the bisque hard enough to keep down blistering in the glost fire. A plant which had varying firing in the periodic bisque kiln discovered serious blistering on dishes. Six 10-inch blistered dishes were taken from the glost kiln and six that were not blistered were taken off the belt as they were unloaded from the same saggers in the same bung of ware on the car. The absorptions of this ware were as follows:

	O. K. ware (%)	Blistered ware (%)
	0.11	1.42
	0.37	1.47
	0.75	1.06
	0.04	1.28
	0.36	1.71
	0.61	1.98
Av.	0.37	1.48

The primary cause of this blistering was not entrapped air in the porous bisque, but volatilization from the heavier or thicker glaze due to the porous body absorbing more glaze when dipped. This blistering was prevented by dipping the bisque into water previous to glazing. The average thickness of the glaze that did not blister was 0.011 inch and the blistered glaze was about 0.014 inch.

(2) Dry Edges on Vitrified Hotel China

Trouble was encountered with dry edges on the ware, especially the top pieces in the sagger. This glost ware was fired to cone 7, which is high for glost ware, especially a lead glaze, so that there was ample opportunity for volatilization of the lead. The closer the ware was set in the saggers the brighter were the pieces below, showing that volatilization was the cause of the dull and dry-edged ware. A $^{5}/_{8}$-inch diameter wad was used and, although the saggers only were bitted, that portion of the ware next to the wad was always dry. Upon inspection, the side of the wads next to the ware was brown and partially glazed due to absorption of lead. In some few cases, especially where the wad had

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (White Wares Division).

been pulled into the sagger by shrinkage, the wads actually had drops of glaze on them.

This wad was cut down to $^{2}/_{8}$ inch in diameter and the saggers bitted with small pieces of wad about 2 inches to 3 inches long. Immediately the dry edges disappeared almost entirely. Where they did not disappear, it was found that the flint wash on the bottoms of the saggers was too wide or overlapped the top inside of the sagger or that the sagger was chipped or cracked. The lead content of the sagger wash was increased and the flint wash was brushed on very thin and narrow, about 1 inch wide or just enough to cover safely the sides of the sagger below, holding the brush on the top outside so that any overlap of flint wash was on the outside of the sagger. The kiln placers also brushed glaze onto all bare spots inside the sagger as they placed the ware.

This procedure not only eliminated all the dry edge but the top pieces were brighter, the glost ware was much cleaner, the sagger dirt was cut down considerably, and the apparent sand spots, which were found to be due to the flint wash, were eliminated.

The foregoing procedure could, of course, be applied to saggers for the manufacture of semiporcelain with equally as good results as when applied to vitrified chinaware.

II Setting of Cones

To gain satisfactory results from pyrometric cones, a great deal of care must be exercised in placing the cones. Some points to watch in placing the cones are as follows: (1) The correct position of the cones in the plaques is to have the same angle of slope to fall either forward or sidewise, whichever is desirable. (2) The cones should be in the same depth in the plaque and the plaque preferably should be uniform in size. The holes cut in the trial saggers should be uniform in size. Many plants cut these holes in the saggers before the saggers are dry, which insures uniformity. Some plants are now placing the cones on pieces of pitcher held between saggers between bungs. This avoids the use of trial saggers altogether.

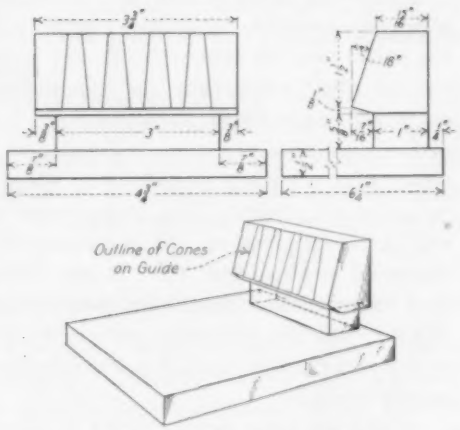

FIG. 1.—Cone plaque guide.

Two convenient gages for setting cones uniformly at the same angle and

depth in the uniform plaque are shown. Figure 1 shows a cone setting form designed to place the cones so that they fall forward when softening.[2] The number side of the cone is faced against the back block directly in front of the cones outlined thereon, so that they lean forward at an angle equivalent to that of the block or 18° from the vertical. The roughly-formed plaque is shoved in under the block and pressed against the undercut side and cut the length of the cone board. This gives a uniform-sized plaque with little time required. After inserting the cones, the plaque is removed by pressure of the forefinger of each hand on the plaque at the cutout ends shown.

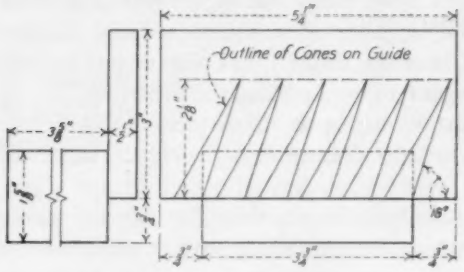

FIG. 2.—Cone plaque guide.

Figure 2 shows a cone setting form used where the cones are set to fall sidewise. The cones are placed with the numbered faces at right angles to the cones outlined on the backboard which are at an angle of 18° from the vertical. Otherwise the method of operation is the same as that for Fig. 1. These forms are made of wood because of the ease of making. Steel forms would probably be even better.

III. Iron Spots on Semivitreous Ware[3]

On one kiln firing of both bisque and glost semivitreous ware, after about a year's operation, the dishes placed in sand began to show iron spots on the surface on the first eight or nine cars following the glost run. It was thought that perhaps the lead vapors from the glost ware were condensing onto the sand between the dishes sufficiently to cause a fluxing of the iron in the sand onto the ware. Trying out various grades of sand from different plants having tunnel kilns, where no such trouble was found, did not cure this fault. The idea of sand alone being the source of trouble was therefore given up. The number of cars on which the specks showed increased as time went on. It was thought that it was either due to the lead vapor in the atmosphere from the glost ware and that which had condensed onto the kiln walls and crown, or it was due to reduction, in spite of the fact that the lowest excess air was 40% at the time the bisque ware was in the kiln.

It was not until several bungs of green dishes placed in sand were fired through the decorating kiln, where the maximum temperature was 1320°F, that the trouble was definitely known to be from reduction. When the

[2] In conjunction with Earl E. Baldauf.

[3] In conjunction with C. L. Pitcock.

ware came from the decorator, it was found that that portion of the dishes which were in sand had become coal black, showing that considerable circulation and amount of oxygen were necessary for oxidation of the clays. At another plant[4] manufacturing insulators, it was found necessary to put holes in the bottom of the saggers in which large pieces were fired in order to get complete oxidation to prevent blue coring.

At first more oxidation air was admitted into the kiln, which helped to a marked degree. Then one hole in the side of the sagger was tried which, together with the increased oxidation air, helped to eliminate the spots. Later two holes straight through the sides of the saggers corrected the spots altogether. To prevent any tendency to warp, approximately 4-inch holes were cut in the two ends of the saggers and no brown iron spots have appeared since.

In checking back, the reason for the appearance of the iron specks was found to be due to a speeding up of the kiln schedule. As insufficient time was allowed for oxidation and likewise, no doubt, as the schedule increased in speed the number of cars containing specked dishes multiplied until the bisque schedule itself was so rapid that all bisque cars contained specked dishes.

IV. Firing Pink Semivitreous Ware[5]

At another plant firing pink semivitreous ware, the color of which was produced by a body stain, there were not only iron spots on the dishes but on various other shapes as well. The pink color also frequently tended to bleach out. All of this difficulty was completely eliminated by giving the kiln more fresh air and bitting with short pieces of wad instead of wadding tight or instead of using no wads at all.

In green saggers, the pink ware fires satisfactorily providing the ware is placed in the top open green saggers and not in those below which are tightly covered, because no wadding or bitting is usually used between green saggers. Holes in the saggers could be used with satisfaction for firing pink ware, but are not necessary. It is also essential to have the ware dry before placing in the kiln.

V. Difficulty with Precipitated Cobalt Stain

In starting up a bisque kiln on vitrified hotel chinaware, some trouble was encountered with bluing of the ware. At first this blue only appeared on mugs at the point where the handles joined the mug itself. Then it appeared on the outside edges of plates, especially heavy grill plates, and increased so that it was found on the edges of bowls and other shapes and occasionally as a streak across the ware. When the blue discoloration ap-

[4] In conjunction with E. H. Fritz and H. M. Kraner.

[5] In conjunction with M. C. Sondles and W. E. Tritt.

peared, it was considered at first to be blue stoning. The fact, however, that it always appeared at that point from which most of the evaporation would take place and on heavy ware which contained more water gave rise to doubt.

In the case of the mugs, the handles were allowed to stand in water and then were welded onto the mug proper. This point of contact, of course, contained more water than the remainder of the mug, so that more water evaporated from this point and the top open edge. It seemed that part of the cobalt stain added was soluble and, in drying, the water was carrying this soluble portion of stain to the surface sufficiently to cause a blue discoloration.

Several mugs that were dry were scraped over their entire surface with a knife so as to remove any soluble salt that might have deposited there during evaporation or drying. After firing through the bisque kiln, these mugs showed no sign of blue discoloration, whereas all of those that had not been scraped showed it plainly.

For preparation of the stain, cobalt sulphate and sodium bicarbonate were used,[6] with presumably the following reaction:

$$CoSO_4 + NaHCO_3 \longrightarrow CoCO_3 + NaHSO_4$$

The cobalt carbonate precipitated out and left the sodium acid sulphate in solution.

This cobalt carbonate is listed in Van Nostrand's Chemical Annual as "insoluble" in both cold and hot water. This led to the belief that perhaps all of the cobalt was not being precipitated as cobaltous carbonate. From the above equation, theoretically, only 84.01 parts of sodium bicarbonate ($NaHCO_3$) are required to precipitate 281.14 parts of cobalt sulphate ($CoSO_4 \cdot 7H_2O$) or one pound of sodium bicarbonate will precipitate 3.35 pounds of cobalt sulphate. One pound of sodium bicarbonate was being used to precipitate 0.75 lb. of cobalt sulphate, which was sufficient for the above reaction. Even if the cobalt sulphate were dehydrated in the form of $CoSO_4$, there still was a large excess of sodium bicarbonate for the reaction.

On pouring off the supernatant liquid from the cobalt carbonate precipitate, the color of the liquid was pink, indicating that there was a soluble cobalt salt still present therein, so that for some reason the above reaction was not taking place completely.

Appleby and Lane (*Jour. Chem. Soc.*, **113**, 609–22 (1918)) describe the preparation of a double carbonate of sodium and cobalt, $Na_2Co(CO_3)_2 \cdot 4H_2O$, using a mixture of sodium carbonate and sodium bicarbonate with cobalt nitrate. This compound cannot be found in the Chemical Diction-

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[6] A. S. Watts (*Jour. Amer. Ceram. Soc.*, **4** [6], 451–52 (1921) Part I) specifies sodium carbonate instead of sodium bicarbonate.

ary or handbooks under cobalt salts but the above reference shows that cobalt is capable of forming compounds not ordinarily listed.

Upon boiling the pink-colored supernatant liquid from the cobalt sulphate plus sodium bicarbonate precipitation, a pink residue formed at boiling temperature and the supernatant liquid cleared, showing that the reaction between sodium bicarbonate and cobalt sulphate was completed.

The following tests were then run:

"A," cobalt sulphate plus sodium bicarbonate in the cold solution gave a pink precipitate hard to filter. After boiling, the pale pink-colored filtrate gave a further dark blue precipitate of cobalt carbonate.

"B," cobalt sulphate plus sodium bicarbonate in a boiling solution gave a dark blue precipitate which filtered easily. Boiling the colorless filtrate gave no further precipitate.

"C," cobalt sulphate plus sodium carbonate in the cold solution gave a dark pink-blue precipitate fairly easy to filter. Boiling the colorless filtrate gave no further precipitate.

"D," cobalt sulphate plus sodium carbonate in boiling solution gave a dark blue precipitate, a shade darker than "B" and easy to filter. Boiling the colorless filtrate gave no further precipitate.

A very weak acetic or hydrochloric acid solution gave far more effervescence with the precipitate formed by a cold solution of sodium bicarbonate "A" than the other precipitates.

The precipitates formed in "B," "C," and "D" will dissolve only in a fairly concentrated acid solution, which would indicate possibly that the precipitates were a mixture of cobalt carbonate and cobalt oxide. The temporary hardness of water as is well known is due to calcium and magnesium bicarbonates, which on boiling are decomposed into water, carbon dioxide, and the practically insoluble normal carbonates of these metals. Thus, in the case of the calcium salt $Ca(HCO_3)_2 \longrightarrow CaCO_3 + H_2O + CO_2$.

Although no record was found of such a compound as cobalt bicarbonate ($Co(HCO_3)_2$), it appears that this compound existed and was at least partially formed in "A," where sodium bicarbonate and cobalt sulphate were used in a cold solution, forming a partially soluble compound, which when boiled gave a completely insoluble precipitate, not so easily acted upon by weak acid solution.[7]

The difference in color of the precipitates and difference in physical structure, as shown by the variation in ease of filtering, might also possibly indicate that boiling hydrated cobalt salts tends to form the oxide, so that in "B" and "D" where the reaction was carried out in boiling solution, a mixture of both cobalt carbonate and cobalt oxide are formed.[7]

If this latter assumption is true, it is highly desirable to precipitate the cobalt in a boiling solution since the possibility of it being decomposed,

[7] In agreement with James R. Withrow, Ohio State University.

as would be true with cobalt carbonate by weak acids getting into the clay slip, is decreased. The precipitate is still in the desirable gelatinous form as when precipitated cold.

It was thought from the foregoing that the difference in precipitates might possibly be due to a difference in the stage of oxidation or valence of the cobalt. J. N. Friend[8] states, however, that "cobaltic carbonate does not appear to be capable of existing in the solid state."

Therefore, the precipitations of stain were immediately made in boiling solution, washing the precipitate three times by decantation with boiling water. The chief reason for washing the precipitate was to eliminate the presence of the sodium bisulphate in solution where sodium bicarbonate was used or sodium sulphate in the case of sodium carbonate as a precipitant.

The outside edges of the flat ware often appeared brighter than the remainder of the ware. This is ordinarily assumed to be due to overfiring, but by eliminating the presence of the strong very soluble sodium fluxing compound by washing, this tendency for bright edges was overcome immediately. No mention is made in the literature of washing the carbonate precipitate or even of decanting off the soluble sulphate formed when preparing the cobalt carbonate stain and it is believed that in many cases where bright edges have been attributed to the firing, they have in reality been due to a concentration of the soluble sodium salt from the stain deposited on the edges during drying.

Since it required several weeks to work out completely all of the accumulated ware made from slip to which had been added the stain precipitated in cold solution, several further tests were made.

A sample of blue edge when tested in the laboratory showed distinctly the presence of cobalt.

(1) A sample of slip from one of the large ball mills in the slip house before the stain had been added was dried on a large plaster mold to remove the water. As the clay dried, a bright green salt collected around the edge of the mass of clay next to the mold. This green scum measured about $^1/_2$ inch in width. This was scraped off and placed in the bottom of an ordinary bisque cup which had been made in production with stain added to the slip. It was fired in an experimental kiln to cone 9. In the bottom of the cup there were many slightly purple-blue crystals and the glass was partially clear and amethyst in color. An analysis of the blue glass showed the presence of cobalt.

(2) Drying out a sample of body clay in a pan on a hot plate to which the stain had been added gave a green scum around the edge. An analysis of this gave cobalt, iron, aluminium, magnesium, sodium, silica, chloride, sulphates, and a trace of calcium.

(3) The source of water was changed because of impurities, possibly caused by soluble cobalt salt. In the meantime a gallon of the old water

[8] Text Book of Inorganic Chemistry, Vol. 9 (1922).

was evaporated to about 50 cc. Upon analysis, the dirty gray solution showed calcium, magnesium, sodium, silica, chlorides, and sulphates, but no trace of cobalt. The remainder of the solution was evaporated to dryness and checked for cobalt, but no cobalt was present.

This residue was divided into two parts. One-half was placed in a platinum crucible and the other half in a bisque cup which had been made from slip containing the cobalt stain. These were fired to cone 13 half down. The residue in the platinum crucible was brown and white in color. The residue in the bisque cup had one purple-blue crystal, the glass varying from a blue-gray to amethyst to colorless, somewhat similar to that previously noted in firing the scum in the cup to cone 9.

On analyzing the residue from the crucible, no cobalt could be detected. Although the glass and crystal in the cup appeared to have cobalt present, the sample was so small when separated from the cup that cobalt could not be detected by analysis.

(4) Another gallon sample of old water was evaporated to dryness and the residue placed in a bisque cup to which cobalt stain had previously been added. This was fired through the bisque kiln and gave a fused mass in the bottom of the cup containing many slightly purple-blue crystals and the glass was partially clear and amethyst in color.

From the foregoing it appeared that the reason for the presence of cobalt in the scum fired to cone 9 in the bisque cup was due to absorption of cobalt from the bisque cup and possibly from the side of the plaster mold during drying. In (2), the cobalt evidently came from the stain added to the body. In (3) the water evaporated partially in the beaker and completely in the platinum crucible, showing that the source of trouble was not due to any cobalt in the water. In (3) and (4), the cobalt evidently came from the stain added to the bisque cup in which the residue was fired, although at this time the stain was being precipitated in boiling solution.

Since traces of blue edges continued even after all of the old ware made with the stain precipitated cold had been used and since the scum next to the plaster mold showed the presence of cobalt, it appeared that possibly at the time some of the cobalt stain was being precipitated cold, the molds had absorbed sufficient of this stain to impart traces of soluble cobalt to the ware. A couple of molds fired through the bisque kiln came out with a decided blue-green contamination around the outside. An analysis showed cobalt present.

It was therefore decided for safety, due to the fact that such care must be exercised in keeping the solutions boiling at all times when preparing the stain from sodium bicarbonate and cobalt sulphate, to precipitate the cobalt in boiling solution with a boiling solution of soda ash instead of bicarbonate and to wash the residue thoroughly by decanting with boiling water three times in order to eliminate the fluxing sodium sulphate. The precipitate settles rapidly, which is a decided point in favor of boiling.

Since this procedure was adopted and time given for the molds to lose their soluble cobalt, excellent results have been obtained.

VI. Colorant for Crazing Tests

In running crazing tests on white ware, it usually requires considerable time to inspect the ware for craze marks after immersion in the cold water. The detection of these craze marks can be facilitated greatly by using a colorant in the water such as potassium permanganate or malachite green.[9] Potassium permanganate in the proportion of about one-hundredth gram to one gallon of water and malachite green in the proportion of about one-thousandth gram per gallon of water should be used. It is best to dissolve these colorants in warm water in a more concentrated proportion and use this as a stock solution so that a few drops can be added to the immersion water. No time is then required for the colorant to go into solution.

VII. Summary

(1) Some forms of glaze blisters on vitrified ware can be overcome by firing the bisque sufficiently hard.

(2) Dry edges on vitrified glost ware can be overcome by using bitting $^3/_8$ inch in diameter and properly glazing and washing saggers. This also helps to decrease sagger dirt.

(3) Cones should be properly set in the plaque, preferably by a gage. The cone plaques also should be set in a uniform position on the car.

(4) Iron spots on semivitreous ware set in sand can be overcome by allowing sufficient oxidation.

(5) Iron spots and bleaching of pink-colored semiporcelain can be corrected by sufficient air being admitted to the ware for oxidation.

(6) In precipitating cobalt carbonate, it is best to precipitate with sodium carbonate in the boiling solution. Washing the precipitate several times by decantation prevents bright edges on the ware due to soluble sodium sulphate formed in the reaction.

(7) The use of a colorant in the immersion water for crazing tests will save considerable time.

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[9] Suggested by A. V. Bleininger.

USE OF SMALL QUICK-ACTING KILNS FOR INSTRUCTION AND RESEARCH[1]

By F. H. Norton

ABSTRACT

Considerable experience with small, quick-acting kilns in the laboratory, both for instruction and research, has indicated the distinct advantages of this type of kiln. By the use of an insulating refractory the mass of the kiln can be reduced to less than one-tenth of that usually employed, which makes rapid heating possible without great expenditure of fuel. Two types of kilns are described which have given good service for a considerable length of time. Temperatures as high as 2600°F can be obtained with atmospheric burners and temperatures up to 3000°F with blast burners.

I. Introduction

In the last two years the laboratory at the Massachusetts Institute of Technology has had considerable experience with small, quick-acting kilns for instruction and research. The practice has been adopted of assigning to each student a small kiln which he fires by himself. To do this it is necessary to have a kiln which can be fired in an ordinary laboratory period of 2 to 4 hours.

II. Advantages

Large pieces, of course, cannot be fired as rapidly as this, but it is believed that a student will learn a great deal more by making a number of firings himself with small specimens than simply by taking the results with everyone else from a common kiln. A number of specimens will undoubtedly be spoiled, but in so doing the student will get a much better idea of firing technique than by any other method.

Furthermore, the small kiln has the distinct advantage of allowing the student to watch the specimens closely while they are being fired and to note at what temperature shrinkage takes place or a glaze matures. Such observations are of the greatest value in forming a lasting mental picture of the firing process.

In some cases it is necessary to use special bodies that will stand the comparatively rapid firing, but this can be readily accomplished in most cases by eliminating free silica from the mix. Glazes will generally give good results with the quick firing. The temperature must be somewhat higher for the short fire than for the long one, but this can be predetermined quite closely.

Examples of experiments carried out in this way include the rapid production of frits which can be made up, melted, and ground in one hour or one hour and one-half. The maturing temperatures of various bodies can be determined as well as other properties, such as their fired color, trans-

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Refractories Division). Received March 5, 1931.

lucency, etc. Perhaps one of the most important uses of the quick-acting kiln is in the development of glazes. It is possible for the student to apply the glaze, fire the specimen, and take it out for examination in an hour's time. If the glaze is not satisfactory the desired alterations can be made and another specimen can be fired. In this way he can reach the desired goal with a great saving of time.

It may be argued that the rapid heating does not reproduce the schedule

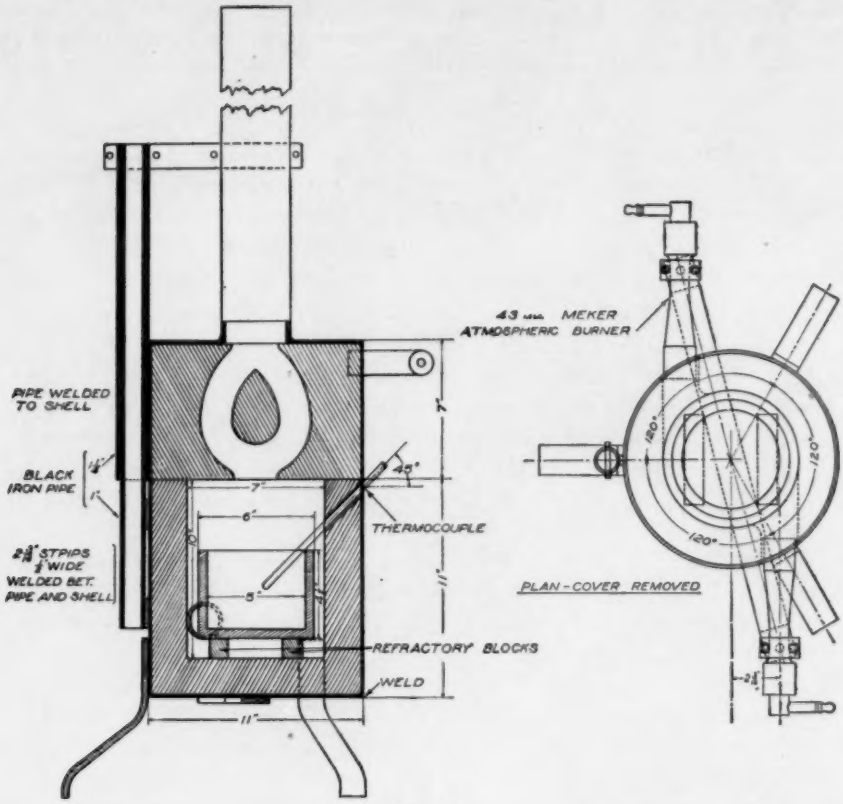

FIG. 1.

usually followed in large-scale production. This is true in most cases. If the student thoroughly understands the relation between time and temperature on the maturing of ceramic products, however, he will have no difficulty in adjusting his point of view to the longer firing at a lower temperature.

Any desired firing schedule can be followed and the ware can be fired with an economy probably as high as for any of the larger periodic kilns. In

the same way as for instruction, a small, thin-walled kiln allows a close observation of the piece being fired, so that the various changes can be noted. If desired, the temperature of the kiln can be held at a constant value for days or weeks by using a gas-pressure regulator. Another advantage of these kilns is the fact that they can be left running unattended for any length of time. This permits the kiln to be started slowly in the afternoon and then to be brought up to temperature the next morning.

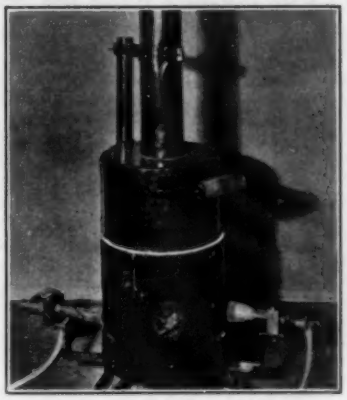

FIG. 2.

Another distinct advantage of rapid firing in research work is the minimizing of the volatilization in glazes or glasses. The final product will approach more closely the analysis of the raw mix. Again in melts, the more rapid the heating, the less danger there is of contamination from the container.

This type of kiln has been particularly useful in the development of glazes. Three or four firings can readily be made in a day. The results of each firing can be utilized to make an intelligent alteration in the formulas for the next trial. It is evident that this procedure saves much unnecessary work and at the same time reaches the desired result quickly.

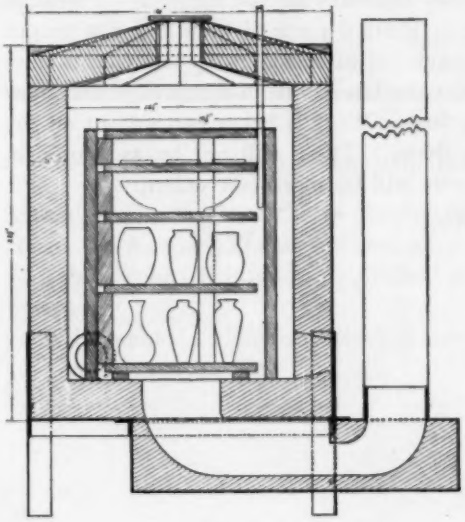

FIG. 3.

III. The Kiln

In Fig. 1 is shown a drawing of a small kiln capable of attaining temperatures rapidly. This kiln requires approximately 80 cubic feet of manufactured gas per hour when running at the maximum rate. An ordinary firing, however, for a glaze maturing at about 1100°C would require 36 cubic feet of gas, which would give an operating cost of only a few cents. Due to the spiral path of the gases, the temperature in the kiln is uniform except at the lowest temperatures.

The high maximum temperature and rapid temperature rise are mainly due to the refractory with which the furnace is lined. This refractory is a kaolin insulator which has been described previously.[2] It is interesting to note that the mass of the kiln to be heated is less than one-tenth of that for the usual construction, which accounts for the low fuel consumption.

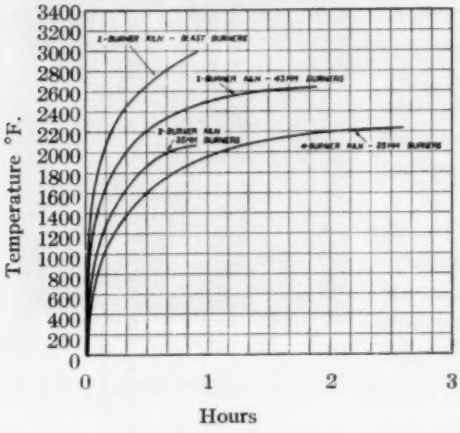

FIG. 4.

A somewhat larger round kiln is shown in Fig. 3. Due to the downdraft principle, the uniformity of temperature throughout the working chamber is excellent when using four 35-millimeter Méker type burners, and with these conditions the kiln consumes approximately 75 cubic feet of manufactured gas per hour. By using 43-millimeter Méker burners a more rapid rise and a higher maximum temperature can be obtained, but this is not necessary for the majority of ceramic work. This kiln will fire a fairly good-sized piece of ware and if a proper body is used it can be fired and taken out in considerably less than a day.

Kilns opening on the top, as these do, have some disadvantages for glaze work due to the danger of falling dust. Work is being carried out on the design of similar kilns with side doors. These will not be as simple in construction, but for some purposes will be more convenient.

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[2] F. H. Norton and C. L. Norton, Jr., "A Small Gas-Fired Laboratory Furnace," *Jour. Amer. Ceram. Soc.*, **13** [3], 161–66 (1930).

SOLUTION OF THE MODULUS OF RUPTURE EQUATION BY MEANS OF A SIMPLE FOUR-VARIABLE CHART[1]

By R. G. Mills

ABSTRACT

A form of nomographic chart for the solution of the modulus of rupture equation is described. The chart is direct reading and less time is required for the determination from experimental data than with most methods.

I. Introduction

(1) Purpose The chart shown in Fig. 1 was devised for use in the solution of modulus of rupture equations. It was believed that such a chart would greatly reduce the length of time involved in the solution of such equations.

(2) Scope Only one chart has been included, *i.e.*, that prepared for the standard test piece measuring 7 by 1 by 1 inch whose modulus of rupture in the dried condition is required. The same chart may be used for fired test pieces by multiplying the load and modulus of rupture units by 10.

II. Preparation

The formula for modulus of rupture, $MR = \frac{3}{2}\frac{PL}{bd^2}$, resolves itself into a four-variable equation when L, the length of span, is constant. The equation may then be placed in the form, $\frac{d^2}{1/b} = \frac{kP}{MR}$, which is of the type, $\frac{W}{X} = \frac{Y}{Z}$. Reference to a standard text on graphical representation disclosed several types of charts suitable for the solution of equations of this form. A standard nomographic or alignment chart was chosen as the most suitable type. The following method was used in the preparation of the chart.

With L equal to 5 inches, which is the specified length between supports, the equation reduces to

$$MR = \frac{15}{2}\frac{P}{bd^2} = \frac{7.5\,P}{bd^2}$$

(or)

$$\frac{d^2}{1/b} = \frac{7.5\,P}{MR}$$

Let $x = m_1 d^2$, $y = m_2 \frac{1}{b}$, $z = m_3 7.5\,P$, $t = m_4 MR$

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[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (White Wares Division).

The letters x, y, z, and t represent the distances to be laid off on the axes; m_1, m_2, m_3, m_4, are scale constants so chosen that the range of the scale of each variable will fit in the space provided. Any suitable values may be chosen for m as long as the proportion $\frac{m_1}{m_2} = \frac{m_3}{m_4}$ is maintained.

The following table was prepared which exhibits the limits of the variables, the choice of constants, and the equations and approximate lengths of the scales.

Scale	Limits	Constants	Equation	Length
d	0.5–1.5	$m_1 = 3.333$	$x = 3.333d$	7.5 in.
b	0.5–1.5	$m_3 = 5.0$	$y = \frac{5}{b}$	10.0
P	0– 200	$m_2 = 0.00666$	$z = 0.00666 \times 7.5P$	10.0
MR	0–1000	$m_4 = 0.01$	$t = 0.01MR$	10.0

Four scales were laid out, two on each of two parallel lines (axes) as shown in Fig. 1. These axes were 10 inches long and 5 inches apart, with a diagonal line joining the two origins as shown, and were constructed on standard graph paper. The solution of the equations shown in the table determined the spacing of the divisions on the scales.

III. Use

The chart is direct reading requiring no additional computation and the modulus of rupture is determined directly from experimental data. A straight line is drawn from the value of d, the depth of the bar, to the value of b, the breadth of the bar. A second straight line is then drawn through the value of P, the load, and the intersection of the first line with the permanent diagonal, and extended until it cuts the MR axis. This intersection with the axis may then be read on the MR scale and gives the value of the modulus of rupture. It is not necessary to mark up the chart with construction lines as a reference point on the diagonal is all that is necessary. The reading may then be made along a straight edge without the use of any constructed line.

The time required for the use of the chart has been found to be less than half of that required for slide-rule calculations and approximately one-fifth of that required for longhand calculations. Results are checked more easily than is possible in any calculated method.

IV. Example

An example of the determination on one piece is shown on the chart in Fig. 1. The depth of the piece is 0.93 inch, the breadth of the piece is 0.87 inch, and the load is 72 pounds. An examination of the constructed lines shows that the extended line cuts the MR axis at 715 lb. per sq. in., which is the value obtained by slide-rule calculation.

The chart shown may also be used for fired bars by multiplying the load and modulus of rupture units by any constant. This, of course, does not

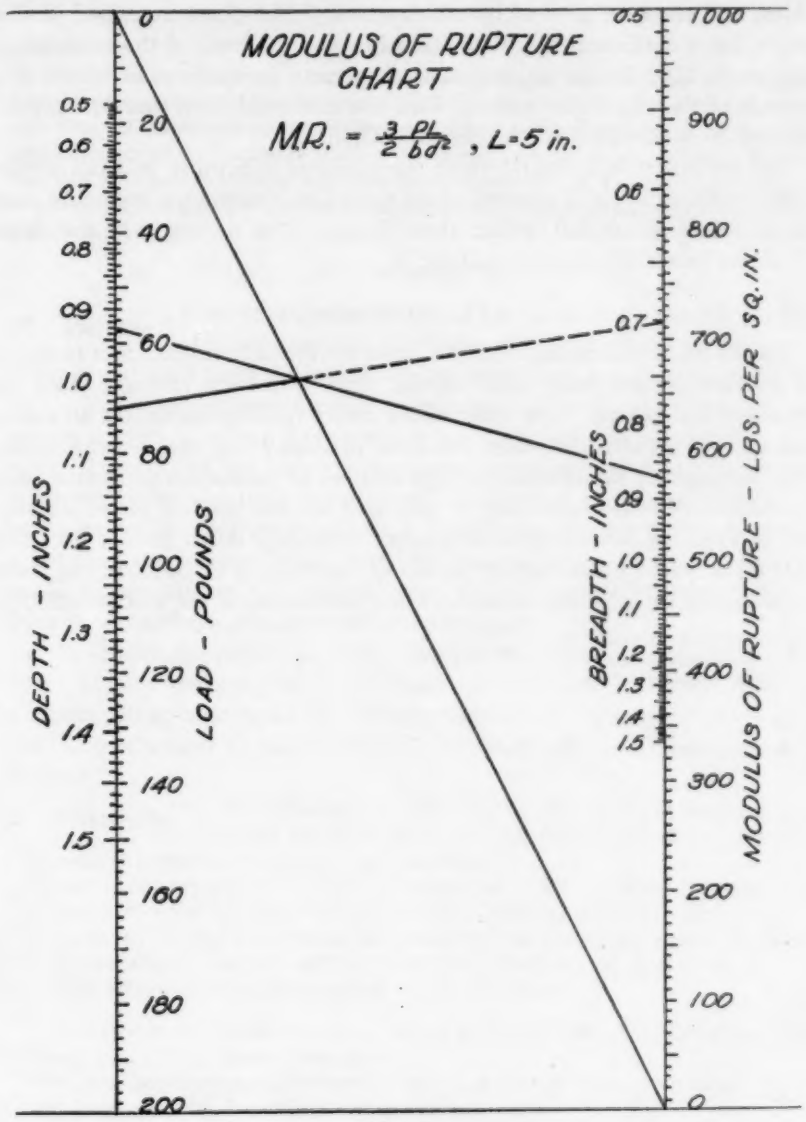

FIG. 1.

change the proportion existing between the two scales. Multiplying by 10 allows the use of load values up to 2000 pounds and the limiting value of the modulus of rupture is 10,000 lb. per sq. in.

V. Accuracy

The accuracy of the chart depends upon its size, the limits of the variables, and the care used in its construction. The chart described in this paper has a maximum height of 10 inches and the limit of the modulus of rupture is 1000 lb. per sq. in. The chart may be easily read within five pounds of the calculated value. This is considerably less than the experimental error involved in the determination.

For control or other work where the modulus of rupture will fall within rather narrow limits, a separate chart should be constructed including only those values which fall within these limits. The accuracy of the chart would be increased proportionately.

VI. Summary

The chart described has been prepared for the determination of modulus of rupture values from experimental dry, transverse-strength data on standard test pieces. The chart being direct reading eliminates all calculations and greatly decreases the time necessary for the determination. It is particularly useful when a large number of these determinations must be made. Similar charts may be prepared for any size test piece, whether dry or fired, by proper choice of limits. Charts of much greater accuracy may be prepared by increasing the size of the chart or by constructing them for a narrow range of the variables where conditions of use will permit this.

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THE MELTING RELATIONS OF POTASH FELDSPAR, SODA FELDSPAR, AND FLINT MIXTURES[1]

By C. R. Amberg and J. L. Gallup

ABSTRACT

P.C.E. values of ternary mixtures of potash feldspar, soda feldspar, and flint were determined and results shown on a solid phase diagram. No eutectics were developed with either of the binary series of feldspar and flint. The soda feldspar-flint mixtures were more refractory than were those of the potash feldspar series. At least 20% flint variation with potash feldspar will show no change in P.C.E. values and at least 10% with the soda feldspar showing the unreliability of P.C.E. to indicate the amount of the quartz content.

I. Introduction

(1) Purpose A large amount of work has been done on the melting and deformation relations of binary mixtures of potash feldspar and soda feldspar, potash feldspar and flint, and soda feldspar and flint. The melting or deformation relations of ternary mixtures in the ternary system, however, have scarcely been touched experimentally. The reported results of the different authors concerning the binary mixtures, moreover, differ widely in many cases. In spite of the lack of definite information on the melting relations of the three components in the interior of the field and in spite of the fact that much of the reported information on the binary mixtures is contradictory, many users of feldspar still purchase it on the basis of a cone deformation test.

With the above points in mind, the present investigation was undertaken, (1) for the purpose of checking the reported binary deformation eutectics, (2) to investigate the melting relations of the interior of the field, and (3) to discover to what extent P.C.E. indicates the composition of a feldspar.

(2) Literature J. W. Mellor,[2] in 1905, reported a potash feldspar-flint melting point eutectic at 75% feldspar and 25% flint.

Simonies[3] found no feldspar-flint eutectic.

Watts[4] first reported a slight eutectic at 95% potash feldspar and 5% flint, but later[5] he reported one at 90% feldspar and 10% flint.

Minniman,[6] firing in a commercial pottery kiln, found no potash feldspar-flint deformation eutectic, but noticed that additions of quartz up to 15% had little effect on the deformation of the feldspar.

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[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (White Wares Division).

This investigation was carried out at New York State College of Ceramics as part of work for degree of B. S. in Ceramic Engineering.

[2] *Trans. Ceram. Soc.* [Eng.], **4**, 49–65 (1904–1905).

[3] *Spreschaal*, No. 30, 1907.

[4] *Trans. Amer. Ceram. Soc.*, **14**, 87 (1912).

[5] *Ibid.*, **15**, 144 (1913).

[6] *Ibid.*, **15**, 101 (1913).

Hanna[7] reported the potash feldspar-flint deformation eutectic at 96% feldspar and 4% flint.

No eutectic has been reported in the soda feldspar-flint series.

Watts[5] gave a eutectic between potash and soda feldspars at 69% albite and 29% microcline.

Alling[8] cited eutectics in the potash-soda feldspar series reported by various investigators[9] as ranging from 30% orthoclase and 70% albite to 42% orthoclase and 58% albite.

II. Experimental

(1) Materials Buckingham feldspar was used for the potash feldspar, Maryland feldspar for the soda feldspar, and Illinois flint for the flint. The feldspars[10] together with the chemical analyses are given as follows:

	Analyses	
	Buckingham feldspar	Maryland feldspar
Silica	64.21%	68.43%
Alumina	20.10	19.95
Iron oxide	0.07	0.056
Calcium oxide	0.14	0.55
Magnesium oxide	0.09	0.03
Potash	13.17	1.08
Soda	2.08	9.58
Loss on ignition	0.10	0.33

It is recognized that any results reported here are strictly applicable to mixtures of these materials only, but with other feldspars of the same type the results should be essentially similar.

(2) Method The P.C.E. of cones were made of various mixtures of the raw materials. This method will, of course, not give true eutectics, for the mixtures are not completely fused at their cone fusion temperatures. In bodies, however, the important consideration is the way in which melting proceeds. This is one of the things that a P.C.E. test shows. This method, moreover, will show the effect of composition on P.C.E. and the value of P.C.E. determinations as a method of testing feldspar.

The materials were screened through a 60-mesh screen to remove sticks and solid chunks, dried bone dry, and the mixtures weighed out. These were mixed by agitation with 50% water for twenty minutes in a shaker.

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[7] *Ibid.*, **17**, 702 (1915).

[8] *Jour. Geol.*, **19** [3] (1921) and **21** [4] (1923).

[9] (*a*) J. H. L. Vogt, *Tsch. Min. Petro. Mitt.*, **24** (1905); **25** (1906); **27** (1908). (*b*) C. H. Warren, *Proc. Amer. Acad. Arts & Sci.*, **51** [3], 148 (1915). (*c*) E. Dittler, *Tsch. Min. Petro. Mitt.*, **21**, 513 (1902). (*d*) E. Makinen, *Sonderadb. aus. Geol. Foren. Förhandl.*, **39** [2], 121–84 (1917). (*e*) Robert Marc, Chemische Gleichgewishtslehre, p. 102.

[10] Supplied by the Consolidated Feldspar Corporation.

They were then dried bone dry. The cones were formed to standard size using a weak solution of starch paste for the bond.

The plaques used were 5 by $2^1/_2$ inches in size and held a double row of cones, the more fusible ones being placed in the front row as far as possible. Five standard cones were distributed over the plaque, two in the front row, one in the rear, and one at each end of the plaque between the rows. This was done to detect any unevenness of heat distribution that might occur.

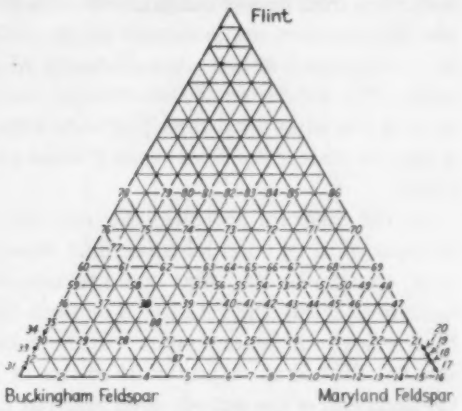

FIG. 1.—Triaxial showing compositions investigated (see table for P.C.E. values found).

The plaques were fired in a gas-heated muffle, 7 by 6 by 14 inches in size, with the front (7- by 6-inch end) open to the kiln atmosphere. When the standard cone placed in the center of the front row of a plaque had registered, the plaque was withdrawn through the opening made by removing a brick from the center of the kiln door. The danger of freezing cones on the plaques remaining in the kiln was avoided by adjusting the stack damper to force the flame out of the opening in the door during removal of plaques. From 24 to 30 hours were used in each firing. Up to cone 2, the temperature was increased about 50°C per hour. After cone 2, the rate of increase was decreased to 20°C per hour. This required the withdrawal of a plaque about once an hour.

A total of 15 firings was made in which over 1000 cones were fired, counting duplications. Ninety points were investigated and nearly every one checked one or more times.

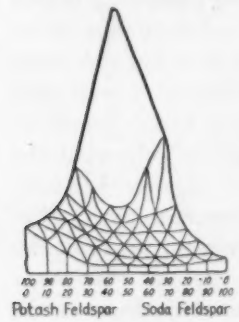

FIG. 2.

III. Results and Discussion

A solid-phase diagram shows the results of the investigation more clearly than any detailed description can. Therefore, the results will be discussed as represented by the deformation contours of such a diagram (see Fig. 2).

This phase diagram or model was constructed using actual differences in temperature between successive cone deformations as vertical distances. The authors felt justified in doing this, employing the temperature values

for a temperature gradient of 20°C per hour,[11] because the firing had been carried out in the manner prescribed for the values used.

Horizontal distances represented composition on the triaxial in the customary manner. In the actual construction of the model, the triaxial was laid out on a board, holes were drilled at three-centimeter intervals to represent 10% intervals of composition, and wires of varying lengths to indicate the deformation temperatures of the different compositions were erected in their proper holes. A centimeter of vertical distance was allotted to each 10°C difference of deformation temperature. Clay was then placed around the wires until the tip of each wire just appeared at the clay surface. A plaster master mold was then poured and from it the plaster phase model made.

As the diagram indicates, no eutectic was found in either the potash feldspar–flint or soda feldspar–flint binary systems. It was found, however, that up to 20% flint could be added to potash feldspar without materially affecting the P.C.E. The same thing was true in the soda feldspar-flint series to a lesser extent. Here a composition containing 15% flint was the first to show any marked rise in P.C.E. value Compositions near the soda end of the potash–soda feldspar binary system also showed no large change of P.C.E. for changes in composition. The mixtures of flint and feldspar were not investigated at compositions higher than 50% flint because of the rapid increase in refractoriness.

It is interesting that the 50-50 mixture of flint and soda feldspar deformed at a temperature nearly a full cone higher than the corresponding 50% mixture of flint and potash feldspar which deformed slightly under cone 13. This was rather unexpected and was checked repeatedly before it was accepted as a fact. No explanation is offered as yet for this situation but it has an important bearing on the effect of flint in bodies and many glazes in which the amount of flint is practically always equal to or greater than the amount of feldspar. Accordingly, soda feldspar bodies should be more refractory than potash feldspar bodies. This is precisely what the Bureau of Standards found in a recently published investigation[12] of feldspars. They reported that bodies high in potash feldspar overfired more quickly than bodies high in soda feldspar, which is equivalent to saying the soda feldspar bodies are more refractory.

The potash feldspar–soda feldspar binary system indicates that a eutectic must be present; the lowering of P.C.E., however, took place in such a wide range of compositions in almost equal amounts that no single composition can be singled out as the eutectic. Figure 1 shows the

[11] "Pyrometric Cone-Temperature-Time Relation Table," *Jour. Amer. Ceram. Soc.*, **11** [6], 339 (1928).

[12] R. F. Geller and A. F. Creamer, "Investigation of Feldspar and Its Effect in Pottery Bodies," *Jour. Amer. Ceram. Soc.*, **14** [1], 30 (1931).

broad, flat valley occurring between the two end members. Compositions containing 30 to 40% potash feldspar and 70 to 60% soda feldspar lie in the center of this valley. This seems to agree in part with the work of Alling,[3] Watts,[4] and others. It is likely that if previously fused mixtures were used to make up the cones a more definite eutectic would be found. This possibility will be investigated in a continuation of this work. A considerable amount of silica may be added to any of the mixtures of soda and potash feldspars without appreciably affecting the P.C.E. value.

P.C.E. of Points on the Triaxial

Point	Cone	Point	Cone	Point	Cone
1	9	31	9	61	9
2	8	32	9	62	8
3	7	33	9	63	8
4	6	34	9	64	7½
5	6	35	9	65	7½
6	6	36	9¼	66	7½
7	6	37	9	67	8
8	6	38	8	68	8
9	6	39	7	69	8
10	6	40	7	70	10½
11	6	41	7	71	9
12	6	42	7	72	9
13	6	43	7	73	8½
14	6	44	7	74	9
15	6	45	7	75	10
16	6½	46	7	76	11
17	6½	47	7½	77	10
18	6½	48	8	78	12½
19	6½	49	8	79	11
20	6½	50	8	80	11
21	6½	51	8	81	10
22	6	52	7½	82	10
23	6	53	7½	83	10
24	6	54	7½	84	10
25	6	55	7½	85	12
26	6	56	7½	86	13½
27	7	57	8	87	6
28	7	58	8	88	7
29	8	59	10	89	
30	9	60	10		

In the interior of the diagram, there is no evidence of a ternary eutectic, which is to be expected since no eutectics were found in either of the binary systems of feldspar and flint. The broad valley of the other binary system, however, extends up into the diagram toward the flint corner, narrowing toward the semblance of a eutectic at the higher flint compositions and veering slightly toward compositions higher in soda feldspar. The lack of any trace of valleys extending inward from either of the binary systems of flint and feldspar is further evidence of their absence in the binary systems.

The diagram shows how little a P.C.E. determination is an index to the composition of a feldspar. Many different mixtures of widely varying

composition that have identical cone deformation temperatures can be selected. For example, practically any composition can contain up to 10% free quartz without changing the P.C.E. value. In the case of potash feldspar even larger amounts of free quartz may be present without affecting the P.C.E. Thus, if a P.C.E. determination were relied upon to choose a feldspar, it might easily happen that one containing a large amount of free quartz would be mistaken for one without free quartz. Such a feldspar added to a body without adjusting the quartz content of the body would raise that quartz content dangerously high and materially increase the refractoriness of the mixture. For another example, reference to the diagram shows that certain points in the soda feldspar-flint field have a P.C.E. identical with that of several different compositions high in potash feldspar. Clearly, these compositions would not be interchangeable in a body or glaze, yet they have the same cone fusion temperatures taken by themselves.

IV. Summary

(1) No deformation eutectic could be found either in the potash feldspar–flint or the soda feldspar–flint binary systems.

(2) At least 20% free quartz can be added to the potash feldspar without materially increasing the deformation point.

(3) Likewise, soda feldspar-flint mixtures show no detectable increase of P.C.E. until over 10% flint has been added to the soda feldspar.

(4) The high flint mixtures with soda feldspar are more refractory than the corresponding high flint mixtures with potash feldspar.

(5) There is a broad, shallow valley in the system potash feldspar–soda feldspar. This indicates the presence of some eutectic but none that could be definitely located.

(6) This valley extends up toward the flint corner, becoming deeper and more like a true eutectic.

(7) From the results of this investigation, it seems that a deformation cone test or P.C.E. determination as an index to the composition of a feldspar is of little or no value since many different compositions have identical P.C.E. values.

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COLEMANITE AS GLAZE MATERIAL[1]

By Myrtle Meritt French

ABSTRACT

Experiments were made to find a natural frit which would replace lead and eliminate fritting. Colemanite supplemented by kryolith was found satisfactory, at least at certain temperatures.

I. Introduction

Raw low-fired leadless glazes are needed in certain types of educational institutions. Experiments were undertaken to determine the possibilities of using colemanite as the main flux and kryolith as a supplementary flux. The formula for colemanite as used is CaO, 1.5 B_2O_3, weight 206, and for kryolith Al_2O_3, 3 Na_2O, weight 420. Several series of glazes were made.

The glazes were weighed, ground for one hour and dried, made into a series, and fired to cone 04.

Of these glazes, six were chosen for further experiments. Numbers 5 and 12 were chosen for transparent glazes, 8 and 9 for mats, and 17 and 24 for opaque gloss. Batches were weighed and applied in larger masses and then fired in various kilns. In every case the glazes had the same qualities as the original series when fired to cone 04. The glazes are given as follows:

Formulas

	5	12	8	9	17	24
CaO	0.448	0.446	0.64	0.60	0.5741	0.60
BaO	0.042		0.137	0.10	0.0252	
Na_2O	0.51	0.489	0.213	0.282	0.3271	0.262
ZnO		0.045	0.01	0.018	0.0736	0.138
Al_2O_3	0.18	0.204	0.14	0.1536	0.1944	0.212
B_2O_3	0.672	0.699	0.96	0.90	0.84544	0.90
SiO_2	3.55	3.848	4.20	4.14	4.2168	4.444

Batch Weights

Colemanite	92.3	96.0	131.8	123.6	118.3	123.6
Barium carbonate	8.2		27.0	19.7	5.0	
Kryolith	71.4	68.5	30.0	39.5	47.8	36.5
Zinc oxide		3.6	0.8	1.5	6.0	11.2
Kaolin	2.6	10.6	18.0	14.4	22.0	12.9
Flint	211.8	226.0	243.6	241.2	242.7	251.7
Calcined kaolin						16.6

For testing, white porous tile was used as a body.

During all of the experiments not one of the glazes crazed. There were indications toward a tendency to devitrify.

II. Effect of Varying Al_2O_3 and SiO_2

The next step was to discover the effect of varying Al_2O_3 and SiO_2. Since No. 5 did not lend itself to an extensive variation of Al_2O_3 without

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Art Division). Received March 10, 1931.

necessitating a change of the raw materials supplying the RO column, glaze No. 9 was taken as a mat and No. 17 as a gloss opaque. A triangular series was made: A, glaze No. 9; B, glaze No. 9 with Al_2O_3 0.094 instead of 0.1536; and C, glaze No. 9 with SiO_2 1.8 instead of 4.14. The side between A and B gave all good mats which were slightly drier toward B. The side between A and C and between B and C gradually changed from a mat at A and B to a good transparent glaze with no crazing at C. The first line parallel with the A to B side gave good mats, especially the two top ones. All others to C were good glazes with a decreasing devitrification on the surface until C was reached.

A second triangle was made using No. 17 as the basis: A, glaze No. 17; B, glaze No. 17 with Al_2O_3 0.109 instead of 0.1944 and SiO_2 4.83 instead of 4.2168; C, glaze No. 17 with SiO_2 1.8 instead of 4.2168. The results of the triangle were as follows: From A to B, the glazes gradually became more mat, B becoming rather dry; from A to C, the glazes became more transparent with decreasing devitrification; C and the one above had none. From B to C, the first was a good mat with a reflecting surface, the second and third had devitrified and the one next to C was a good transparent glaze. All others showed devitrification.

III. Effect of Temperature

The last experiment was to get some indication of what could be accomplished at higher temperatures. A series of six glazes was charted using as A the following glaze calculated for higher temperature.

Formula						Batch	
CaO	0.50					Colemanite	57.68
BaO	0.20					Fluorspar	17.16
K_2O	0.10	Al_2O_3	0.25	B_2O_3	0.42	Barium carbonate	39.40
MgO	0.10			SiO_2	3.01	Buckingham feldspar	59.00
Na_2O	0.10					Kaolin	26.90
						Flint	124.80
						Magnesium carbonate	8.4
						Kryolith	14.3

Three sets of this series were made, one set to be fired at each of the cones, 2, 3, and 4. Glaze A had a beautiful translucent quality but it crawled badly in every case. None of the glazes was good at cone 4. For the most part, there was little glaze left on the tile. At cone 2, the second, third, and fourth glazes were of a good translucent quality but they had crawled from the edge; the fifth and B were both good transparent glazes. At cone 3, the second and third were badly crawled, and the fourth and fifth were good transparent glazes with a slight drawing from the edge.

The formulas of the fourth and fifth were as follows:

FORMULA No. 4

CaO	0.44			SiO_2	3.244
BaO	0.08				
K_2O	0.04	Al_2O_3	0.22	B_2O_3	5.28
MgO	0.04				
Na_2O	0.40				

BATCH No. 4

Colemanite	71.5
Fluorspar	6.8
Barium carbonate	15.7
Buckingham feldspar	23.6
Kaolin	10.7
Flint	172.3
Magnesium carbonate	3.4
Kryolith	56.1

FORMULA No. 5

CaO	0.42			SiO_2	3.32
BaO	0.04				
K_2O	0.02	Al_2O_3	0.21	B_2O_3	0.564
MgO	0.02				
Na_2O	0.50				

BATCH No. 5

Colemanite	76.95
Fluorspar	3.4
Barium carbonate	7.88
Buckingham feldspar	11.00
Kaolin	5.38
Flint	188.16
Magnesium carbonate	1.6
Kryolith	70.0

IV. Solubility

The question of solubility has been raised regarding the keeping qualities of colemanite glazes. Those used for these particular experiments have not been stored wet. Similar ones, however, used at Hull House have been stored for weeks with no apparent change in the fired glaze. There were indications of slight solubility, but evidently there was not enough to injure the glaze.

V. Colorants

In most cases, the use of colorants gave good results. The shades were those to be expected considering the formulas of the glazes. There were exceptions, however. Manganese carbonate blistered violently even in small amounts. Chrome tin pinks appeared very dry and immature. The glaze stains made from antimony and lead likewise blistered violently. Chrome gave a very disagreeable dry green. Doubtless some of these difficulties can be overcome by sufficient time given to experimentation.

VI. Conclusions

(1) It is possible to produce good raw, leadless insoluble glazes to fire at least as low as cone 04, by using colemanite supplemented by kryolith to supply the main flux.

(2) Glazes of this type are much less given to crazing than other raw leadless glazes at this temperature.

(3) A boric mat glaze may be produced by adding SiO_2 to a transparent glaze rather than by subtracting it, as in the case of the alumina and barium mats.

(4) There are possibilities for new color palettes in mat glazes.

(5) The ceramist working with children can have them create their own color schemes without danger of lead poisoning.

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PROPERTIES OF SOME NORTH DAKOTA BENTONITES[1]

By Freida L. Hammers and W. E. Budge

ABSTRACT

Seven samples of North Dakota bentonites were studied. In general, properties of the raw, fired, and acid-treated samples are compared with those of bentonites reported from other districts. The deposits are described briefly.

I. Introduction

Although it has been known for many years that there are deposits of excellent clays in numerous sections of western North Dakota, no comprehensive and detailed study of the extent and nature of these deposits has ever been made. As part of its work in fostering the development of the mineral resources of the state, the Division of Mines and Mining Experiments of the State University has begun an extensive survey of these deposits. During the field work on this survey in the summer of 1930, W. E. Budge located a large deposit of bentonite in the beds of the White River formation in southwestern Stark County.

About thirty-two sections contain bentonite and the deposits range from a few feet to thirty feet in thickness. The deposit nearest the railroad is at a distance of four miles, with good haulage conditions. Much of the material has no cover and can be obtained easily.

This report gives the results of tests made on seven samples of North Dakota bentonites. An attempt was made to classify them and to determine their absorptive and water-softening powers.

II. Experimental Procedure[2]

(1) Swelling in Water A 2.5-gram sample of air-dried bentonite (10- to 20-mesh) was poured slowly with least possible agitation into 100 cc. distilled water in a graduated cylinder. The volume of the clay was recorded after standing twenty-four hours.

(2) Temporary Osmotic Pressure All samples in this series were −100-mesh and dried one hour at 110°C. The collodion mixture used contained 100 parts U.S.P. collodion, 18 parts ether, and 7 parts alcohol. The sacs were made in a 50-cc. Erlenmeyer flask and hardened with a 25% solution of alcohol in water.

Test 1: A one-gram sample was allowed to stand in 10 cc. distilled water in a small beaker for at least half an hour (in some cases overnight, es-

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[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Structural Clay Products Division). Revised copy received June 19, 1931. Contribution from the Division of Mines and Mining Experiments, University of North Dakota.

[2] C. W. Davis and H. C. Vacher, "Bentonite, Its Properties, Mining, Preparation, and Utilization," Bur. Mines, *Tech. Paper*, No. 438 (1928).

pecially No. 1500). The beaker was shaken vigorously to loosen the material which was then washed into the sac with 15 cc. water. A tube 12 inches long with $^1/_8$-inch bore was inserted and the bag tied firmly to it just above the water level. The bag was then immersed in one liter of water, which was changed daily for several days. In these untreated samples, however, the highest temporary osmotic pressure was observed in the first six hours.

Test 2: A one-gram sample was heated on a water-bath for two hours with 50 cc. normal sodium chloride and 5 cc. $N/10$ sodium carbonate solution. When cold the clear, supernatant solution was poured off and the bentonite washed into a collodion sac with 25 cc. distilled water and dialyzed.

Test 3: A one-gram sample was boiled with 50 cc. of 25% (by weight) sulphuric acid for one hour, filtered hot, and washed free from sulphates. This sample was then treated with sodium chloride and carbonate as in Test 2 and dialyzed.

(3) Loss in Weight The tests for loss in weight air-dried to 110°C, and from 110 to 520°C were recorded for untreated and acid-treated bentonites.

(4) Dye-Absorption These tests were made on untreated and acid-treated bentonites heated to 110 and 520°C. In the acid treatment, 10-gram samples were boiled on the hot plate with 500 cc. of 25% (by weight) sulphuric acid, filtered, washed free from sulphates, air-dried, then heated one hour at 110°C.

The dye used was a 0.4% solution of malachite green. A standard color for the end-point contained one drop of dye in 25 cc. water.

To 25 cc. distilled water in a 50-cc. glass tube was added 0.25 gram of the bentonite, then 5 cc. $N/10$ sodium oxalate. The tube was shaken vigorously until the material was well dispersed. After standing overnight a measured amount of dye was added and the tube shaken vigorously again. If the color faded on standing, a new test was made; if the color reached the required intensity and had not faded after two weeks, it was considered permanent. Addition of 5 cc. normal sodium chloride solution flocculated the suspended material.

(5) Water-Softening Tests[3] (Conducted by E. N. Gilje): These tests were made on untreated clays air-dried and heated to various temperatures, on fired clays which had been acid-treated, and on acid-treated clays after reaction with saturated sodium chloride solution. In the acid treatment, 10 grams of the fired sample were heated for one hour with 300 cc. 50% sulphuric acid solution. This

[3] R. B. Ladoo, "Bentonite," Bur. Mines, *Rept. of Invest.*, Serial No. 2289, p. 1 (1921); Hugh S. Spence, "Bentonite," Canada Dept. of Mines, Mines Branch, No. 626, p. 30 (1924); C. W. Davis and H. C. Vacher, *loc. cit.*, p. 48–49; C. C. O'Harra, "Bentonite, Its Occurrence, Properties, and Uses," The Black Hills Engineer, Jan., 1929, p. 45.

washed sample was later heated for one hour on the hot plate with 300 cc. saturated sodium chloride solution.

To 100 cc. city water of known hardness was added 10 grams bentonite. After a definite length of time a soap test was made to determine the hardness.

III. Results

(1) **Color** The raw bentonites vary from pale cream to tan and gray. When fired to 520°C the colors are tan or light orange-brown. Acid treatment bleaches most of the samples except the gray one (No. 1500), and firing to 520°C fails to alter this color.

(2) **Weathering** Samples No. 601 and No. 701 are weathered, the rest unweathered bentonites.

(3) **Composition** The chemical analyses of two samples (No. 701 and No. 1500) are compared with those of samples from other districts in Table I; No. 701 compares with a bentonite from the Trojan Mining Company, Deadwood, South Dakota, and No. 1500 with one from near Rock Creek, Wyoming.

TABLE I

CHEMICAL ANALYSES OF BENTONITES

	Bentonite* (%)	No. 701† (%)	Bentonite** (%)	No. 1500‡ (%)
SiO_2	67.2	67.8	60.18	61.91
Al_2O_3	18.6	18.2	26.58	30.80
Fe_2O_3	0.7	6.1		4.06
CaO	0.9	1.9	0.23	1.05
MgO	1.9	0.9	1.01	1.40
Na_2O	2.1	0.65		0.28
K_2O	Tr.		1.23	0.23
H_2O	8.55	8.4	10.26	
Loss 105–1000°C	4.35			
Loss 110–900°C		4.55		

* From Trojan Mining Co., Deadwood, S. D. (Davis and Vacher, Bur. Mines, *Tech. Paper*, No. 438, p. 10 (1928)).

† Analyst, E. Y. Johnson.

** Type material from near Rock Creek, Laramie Basin, Wyo. (R. B. Ladoo, Bur. Mines, *Rept. of Invest.*, Serial No. 2289, p. 5 (1921)).

‡ Given by Dakonite Chemical Products Co.

The experimental data are recorded in Tables II and III. The acid-treated samples decolorize the dye solution only on very long standing, so the results are of doubtful value and not recorded. They tend to indicate, however, that on an equivalent basis the absorption is lower than for raw bentonite.

IV. Conclusions

The volumes occupied by 2.5 grams bentonite in 100 cc. water varied from 7 to 16 cc., comparable with alkali bentonites.

The temporary osmotic pressure of the majority of the untreated samples ranged from 1 to $1^1/_4$ inches. Sample No. 1500 gave erratic results varying from $1^3/_4$ to $3^3/_4$ inches when heated to 110°C, or as high as 5 inches when

TABLE II

PROPERTIES OF NORTH DAKOTA BENTONITES

		Temporary osmotic pressure			Loss in weight				Dye-absorption ratio (approximate)	
No.	Swelling in water (cc.)	Test 1 Raw (inches)	Test 2 Alkali treatment (inches)	Test 3 Acid then alkali treatment (inches)	Air-dry to 110° (%)	From 110–520° (%)	Raw to acid treated 110° (%)	Acid treated 110–520° (%)	Raw (110°)	Fired (520°)
601	11.5	$1^1/_8$	$1^1/_8$	$1^1/_8$	6.91	3.86	18.9	2.99	0.22	0.17
"		$1^1/_{16}$	$1^9/_{16}$	$1^5/_8$						
602	16.0	$1^1/_8$	1	$1^7/_{16}$	4.10	1.45	18.5	1.81	0.13	0.14
"		$1^1/_8$	$1^1/_8$							
701	10.0	1	$1^3/_4$	$^3/_4$	6.35	3.40	18.9	2.43	0.18	0.17
"		$1^1/_{16}$	2							
702	9.5	$1^1/_4$	1	$^{11}/_{16}$	3.01	1.63	14.6	2.30	0.07	0.065
"		$1^3/_4$	$1^1/_8$							
703	10.0	$1^1/_{16}$	$1^3/_8$	$1^1/_{16}$	2.61	1.83	21.5	1.08	0.08	0.075
"		$1^1/_8$								
901	7.0	$1^1/_8$	$1^3/_4$	$^7/_8$	3.20	1.99	31.5	2.39	0.28	0.44
"		$1^5/_{16}$								
1500	11.0	$1^3/_4$	$1^3/_4$	$1^1/_4$	2.57	2.52	20.8	2.93	0.14	0.14
"		$3^3/_4$								

air-dried at room temperature. It generally broke the bag in the process of preparing the tests. The change in osmotic pressure of the samples on alkali treatment, or acid and then alkali treatment, was hardly enough to

TABLE III

EFFECT OF BENTONITES IN WATER-SOFTENING*

		Fired bentonites; time of contact 48 hours (10-gram sample)			Fired bentonites treated with acid, then saturated sodium chloride solution; time of contact 24 hours (10-gram sample)		
No.	Heat treatment (°C)	Fineness (mesh)	Soap (cc.)	Parts per million	Fineness (mesh)	Soap (cc.)	Parts per million
601	500	4–14	3.0	20	4–14	2.2	12
602	"	"	3.4	24	"	3.4	24
701	"	"	3.0	20	"	1.6	6
703	"	"	2.6	16	"	2.0	10
703	700	"	3.2	22	"	4.2	32
1500	450	14–28	5.0	40	14–28	1.2	2
City water (100 cc.)			22.5	210		20.0	190

* Experiments conducted by E. N. Gilje.

permit definite classification. The samples showed good dispersion, although the treated ones sometimes required several days or a week to attain it.

Because of the method used for testing dye-absorption, these values are

only approximate. The ratio of dye to clay for the raw bentonites varied from 0.07 to 0.28, which is lower than most values reported by Davis and Vacher. The values for bentonites fired to 520°C were about the same as for raw bentonites except in one case (No. 901). This bentonite was more effective as an absorbent when fired to 520°C.

For water-softening, bentonites fired at temperatures ranging from 450 to 700°C were less efficient than raw bentonites except on standing 48 hours. With bentonites fired and then acid-treated (probably not free from sulphates), the hardness increased enormously, becoming greater on standing. After reaction with saturated sodium chloride, however, these acid-treated bentonites were found to be the most effective, reducing the hardness from 195 to 10 or less parts per million.

V. Summary

The degree of swelling in water would indicate that the seven North Dakota samples tested are alkali bentonites. Failure to obtain really high temporary osmotic pressures and high dye-absorption values would make this classification uncertain.

The dye-absorption ratio is not altered on firing to 520°C in most cases.

Fired bentonites which have been treated first with sulphuric acid and then with saturated sodium chloride solution are most effective in reducing hardness in water.

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OBSERVATIONS ON CRAZING IN TERRA COTTA GLAZES[1]

By C. W. Planje

ABSTRACT

Theories and observations for the prevention of crazing in a leaded fritted lustrous glaze are given. The use of various raw materials and their effect upon a glaze with respect to crazing are discussed and several recommendations are made.

I Introduction

This paper is limited to a discussion of the crazing of lustrous enamels, which on terra cotta are quite difficult to control. Crazing is a body defect as well as a glaze defect, but the body in this case is fixed so that the correction lies entirely in the glaze.

The method used of testing crazing in the glazes under discussion was the autoclave test of H. G. Schurecht.[2]

II. The Study Made

(1) The Base Glaze The formula for the base used is as follows:

$$\left.\begin{matrix}0.166\ K_2O\\0.166\ MgO\\0.559\ PbO\\0.109\ ZnO\end{matrix}\right\}\quad 0.268\ Al_2O_3\quad\left\{\begin{matrix}2.122\ SiO_2\\0.192\ SnO_2\end{matrix}\right.$$

The entire RO group and the tin oxide were incorporated in the frit, while the remaining alumina and silica were added as clay and flint.

This glaze in the autoclave showed coarse-mesh crazing. It was finally so adjusted as to show no signs of crazing either with the autoclave or the quenching tests. This adjusted glaze applied to a free standing piece which was weathered for a period of twenty-three months showed no crazing.

(2) Adjustments Made The addition of zinc, either in the frit or by mill addition, gave an increased tendency to craze. This fact is a direct contradiction to the effect of this metal in raw glazes. The best results with respect to crazing were obtained with no zinc whatsoever in the glaze. The loss of opacity which the omission of zinc naturally gives must be taken care of in an increased tin content or the substitution of Cornwall stone in place of some of the flint and clay.

The increase of silica in the frit gives no noticeable change in the crazing tendency, except an almost imperceptible improvement. No remedy can be expected in this adjustment.

Addition of silica in the mill addition has a tendency to produce even more severe crazing and although improving the general appearance of the glaze this adjustment was also discarded.

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[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Terra Cotta Division). Received March 20, 1931.

[2] "Testing of Crazing in Glazes," *Jour. Amer. Ceram. Soc.*, 11 [5], 271–77 (1928).

The substitution of Cornwall stone for flint and a part of the clay in the mill addition decidedly counteracted the tendency to crazing. It was found that alumina and silica in the form of Cornwall stone, when added to a mill addition where these oxides are required, gives decidedly less crazing than when silica and clay are used. Increasing the Cornwall stone within a reasonable limit for this type of glaze gave a decided improvement in crazing.

The substitution of Cornwall stone and clay for a portion of the feldspar in the frit, however, gave an increased crazing tendency, as did the direct substitution of Cornwall stone for a portion of the feldspar and lead. It is therefore advised to use Cornwall stone as a direct substitute for clay and flint only.

The various types of clays also have a decided effect upon crazing of this glaze. The use of a less refractory clay such as ball clay, although beneficial to a glaze in many ways, has a tendency to increase the crazing. Kaolin or china clay, on the other hand, is a great aid in overcoming the crazing defect despite the fact that it contributes but little to the bonding power of the glaze.

The introduction of a calcined clay above the desired alumina and silica equivalents gives a strong crazing tendency, which is undoubtedly due more to the immaturity than to the characteristics of a calcined clay. If the calcined clay, however, is introduced at the expense of a clay not calcined, the behavior is exactly reversed. In other words, a calcined clay proved to be a benefit to the correction of crazing as long as its introduction did not affect the maturity of the glaze.

The introduction of calcium fluoride in a small amount not exceeding 0.06 equivalent had a very disastrous effect on the crazing of the enamel. It did, however, add considerable brilliance and luster to the glaze. By adding a fatty clay, fusible at a low temperature, most of the ill effects of the fluorspar contributing to crazing were removed, but in return the beautiful luster of the glaze was destroyed. The use of fluorspar in this connection would not be recommended.

The addition of magnesia to about 0.175 equivalent, whether included in the frit formula or added as a part of the mill batch, gave increased crazing. The most suitable magnesia content was found to be about 0.16 equivalent.

The addition of a small amount of barium carbonate was attempted in the mill batch, and gave promising results with its reaction toward crazing. The brilliance of the glaze was, however, noticeably dimmed by the barium addition. It was thought, therefore, that this material should be eliminated from the formula as a real lustrous enamel was desired.

The addition of the alumina and silica to the mill addition in the form of feldspar had a material effect upon the crazing tendency of the glaze. Up to 0.06 equivalent, this material made the glaze more resistant to

crazing, however, tending at the same time to dull the brightness of the enamel. Above 0.06 equivalent, the enamel showed signs of blistering caused by the establishment of too low a fusion point. This remedy seems quite plausible if there is no radical objection to the alkali introduced.

(2) Boric Acid The addition of a small amount of boric acid, in the proximity of 0.02 equivalent, to the mill addition had a favorable effect upon the crazing defect. This would seem to agree with Seger's contention that the introduction of boric acid into the unfritted portion of a glaze decreases the coefficient of expansion of the glaze. When added in the frit formula, its action on crazing, however, is precisely reversed. When added in excessive amounts to the mill addition, the glaze upon standing will develop a number of very small and fine boric acid crystals which are objectionable.

(3) Lepidolite The addition of lepidolite was attempted, due to the beneficial results obtained on raw glazes by H. E. Davis.[3] The introduction of lepidolite from 0.01 to 0.137 equivalent in the mill addition had no material effect upon the crazing tendency of the enamel. The gloss of this glaze also was not materially affected as was expected. No final conclusions can be made on this material, however, until its use in the fritted formula has been attempted. As such it would be used as part of the feldspar.

Various opacifiers such as tin or zircon were added to the enamel with a very slight change in the crazing tendency. It was, however, noted that in an enamel where no crazing is evident, an adjustment must be made upon the introduction of an opacifier. This adjustment is most often made by a slight lowering of the frit content or the introduction of a flux in the mill batch. Unless this is done, the experiments have proved that the lack of such an adjustment causes the glaze to craze.

Severe crazing was evident in all glazes not mature, regardless of the reason for immaturity. Several glazes whose resistance to crazing have been tested by the Bureau of Standards, showed severe crazing when immature.

In the firing of the samples for this experiment, various durations were tried, covering, in all, several periods from 110 to 250 hours in length. In all cases, glazes subjected to a longer heat-soaking period were more resistant to crazing that those fired and cooled more rapidly. It would seem best, therefore, to subject the ware to as long heat treatment as possible.

III. Conclusions

From the results obtained in these experiments, the following facts were assimilated:

For a glaze common to the type and character of the one under dis-

[3] H. E. Davis and R. L. Lueders, "Use of Lepidolite in Zincless Glazes," *Jour. Amer. Ceram. Soc.*, **14** [8], 562 (1931).

cussion, the absence of zinc is desirable to a glaze immune from crazing. The introduction of silica and alumina as Cornwall stone in place of flint and clay was found to be a corrective measure, as well as the introduction of boric acid in relatively small quantities. Introducing calcined clay at the expense of raw clay to a point not affecting the maturity of the glaze can be recommended. The use of lepidolite cannot seriously be recommended or should be barred until an opportunity to try it in frits has been accomplished. The duration of fire, as has been mentioned, would seem to favor the long soaking heat, but this cannot be enumerated as a recommendation inasmuch as the use of tunnel kilns having innumerable advantages has been found to be just as successful despite their shorter firing schedule.

NORTHWESTERN TERRA COTTA CO.
2525 CLYBOURN AVE.
CHICAGO, ILLINOIS

OVERGLAZE POLYCHROME CONE NO. 6[1]

By A. M. Strusholm

ABSTRACT

The colors and glaze described enable the operator to paint figures, landscapes, or any decorations desired over an unfired glaze sprayed over a flat surface. Not having the ornament modeled in bas-relief, the ware can be fired with the regular terra cotta to cone 6.

The body glaze can be sprayed over a terra cotta body having 35% calcined grit added. If a more sandy body is used, less silica should be added to the glaze to counteract crazing.

I. Introduction

Painting over the glaze with vitrified colors or stains was used in Holland and England on the so-called Delft ware more than a century ago, but they used a soft lead and tin enamel maturing at cones 010 to 1. Consequently they had a wider range of colors than is possible at cone 6.

There are several advantages of painting over the glaze, especially for interior decoration and where the modeling is in low relief. If ordinary opaque glazes are used they conceal the ornament too much.

It takes less time to paint over the glaze; it also takes fewer colors, and more intensity and better harmony of color are obtained than by adding the stains in the glaze.

When the stains are mixed with a medium and applied over the glaze they are the same color before and after the firing. This assists the operator to get better perspective and harmony of colors. Light or dark shades may be obtained by applying the stain, light or heavy. If sharp high lights are wanted, most of the colors are brushed off the body glaze. By blending the stains or by painting one over the other, many pleasing tones may be obtained.

Many of the stains now on the market may be used for the overglaze painting and polychrome at cones 3 to 6, but all of them are not suitable for all glazes.

A system and a set of colors have been developed by the writer for overglaze polychrome and painting to be fired at cone 6. One of the first jobs was a faience course in the lower hall in the Municipal Building, Hartford, Connecticut, executed in 1913 by the South Amboy Terra Cotta Company.

II. Conditions

One of the most important parts of overglaze polychrome is a suitable glaze for the background. The glaze and stain must mature at the same degree of heat. The glaze must not exert too strong a solvent action on the stains. If the glaze contains zinc oxide it will turn the green stains to brown.

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Terra Cotta Division). Received December 1, 1931.

If the glaze contains tin oxide and no zinc it will turn the green to a pink. Therefore, zirconium oxide (Opax) is used instead of tin oxide for opacity, and a borax flux instead of zinc oxide for softening the glaze.

Overglaze polychrome gives the best results over a shiny glaze, but it is also used over a mat glaze. Some of the stains do not give exactly the same shade of color on the mat as they do over the shiny glazes, owing to the different percentages of silica in the two glazes.

Recipes of the engobe glazes, stains, and colors (thirty-three in all), were found to be necessary for the average polychrome painting.

Many of the stains can be added to a suitable glaze, from 8 to 12% for ordinary color glazes, but as they are to be used for overglaze painting they naturally are weak in coloring power.

TABLE I(A)

Glaze-flux and engobe for overglaze polychrome (cone 6)	Shiny glaze	Mat glaze	Flux for softening*	Engobe
Potash feldspar	48	52		
English china clay	5	10	14	30
English ball clay	9	5		20
Zirconium oxide (Opax)	7	10		
Flux for softening		8		
Flint	20	7	24	20
Whiting	10	12	12	
Barium carbonate	6	6		
Powdered gum tragacanth	1/16	1/16		1/8
Cornwall stone				30
Tin oxide				1
Borax			50	

* The flux for softening can be drop-fritted.

TABLE I(B)

Black and gray stains for overglaze polychrome (cone 6)	Drab	Dark gray	Black for shading	Ebony black
Flint	63	60		
Whiting	10	10		
Nickel oxide	21	22	8	10
Cobalt oxide	3	3	5	26
Green chrome oxide	3		12	
Manganese oxide		5	14	
Zinc oxide			15	
Sodium uranate			16	
Iron red oxide			30	4
Tin oxide				8
Iron chromate				48
Sodium carbonate				4

TABLE I(C)

Blue stains for overglaze polychrome (cone 6)	Light blue	Dark blue	Celadon blue	Willow blue	Mayarine blue
English china clay	42	28			
Flint		64	42	15	15
Zinc oxide	42		26		
Cobalt oxide	1	8	12	30	49
Green chrome oxide			10		
Potassium dichromate			10		
Powdered glass					28
Sodium carbonate	7			10	
Whiting				45	
Tin oxide					8

TABLE I(D)

Brown stains for overglaze polychrome (cone 6)	Golden brown	Cherry brown	Dark brown	Chocolate brown
Potash feldspar	8			30
English china clay		5	10	
Zinc oxide	14	18		14
Sodium uranate	14		30	
Tin oxide	34	23		
Iron chromate		28		
Green chrome oxide		5		
Manganese black oxide		3		
Rutile	15		30	30
Iron red oxide	15	18	30	
Burnt umber				16
Lead chromate				10

TABLE I(E)

Green stains for overglaze polychrome (cone 6)	Yellow-green	Dark green	Celadon green	Grass green	Nayel green	Sage green
Potash feldspar		20		16		
English china clay	7	10				
Zinc oxide			28			
Flint	46	20	45	12	30	37
Whiting	9			12	22	8
Zirconium oxide (Opax)					12	
Sodium uranate	19					
Potassium dichromate	14	25	12	34	24	
Green chrome oxide		25	12			30
Fluorspar	5			10	12	10
Cobalt oxide			3			
Ammonium chloride				7		
Sodium carbonate						15

TABLE I(F)

Yellow stains for overglaze polychrome (cone 6)	Old ivory	Bright yellow	Dark yellow	Yellow for background
Potash feldspar	30	16	30	20
Zirconium oxide (Opax)	28			28
Zinc oxide		28		
Tin oxide	28	28		28
Sodium uranate	14	28	20	14
Antimony oxide			20	
Cadmium oxide			10	
Rutile			20	10

TABLE I(G)

Stains and colors for overglaze polychrome (cone 6)	Light pink	Dark pink	Shell pink	Lavender	Violet	Purple
Flint	12	20				
Whiting	40	18				
Tin oxide	68	50				
Ammonium chloride	17					
Green chrome oxide	1½					
Sodium carbonate	10					
Fluorspar		8				
Potassium dichromate		3				
Iron chromate		1				
Selenium		5				
Flux for softening			40	10	10	
Light pink			60	86	78	
Dark pink						90
Mayarine blue				4	12	10

In preparing the stains, all of the raw materials are mixed dry and rubbed through a 20-mesh sieve three times, packed tight in flinted saggers, and fired at cone 6. The calcined stains are ground in ball mills with water to pass 200-mesh sieves, and after settling are poured on plaster of Paris slabs to absorb the rest of the water, and then dried and repulverized.

A mucilage is made of 2 ounces gum tragacanth and 2 ounces formaldehyde to one gallon of water. As the gum is slow to dissolve, it is ground for one hour in a ball mill. This mucilage will keep fresh for months.

When the stains are wanted for painting, 1 ounce stain, 2 ounces mucilage, and 2 ounces of glycerine are rubbed through a 200-mesh sieve, using a piece of soft rubber of suitable size. It is stored in pint or quart glass jars properly labeled. Where a combination of stains is used it is best to grind the mix with the mucilage in small ball mills.

If a large surface is to be covered, the stains may be applied with a small spray gun, but care should be taken not to spray too heavily. Just enough stain should be used to cover the white glaze. For spraying, the glycerine may be left out of the medium.

If the terra cotta is well pressed and finished, the glaze can be sprayed on it without engobe (two ordinary coats at a gravity of 50 to 55° Bé scale). If the clay body is rough and coarse grit, it is safer to apply the engobe in two light coats at 40 to 45° Bé under the glaze.

With a long soft hair brush of proper size, of the same quality as is used for water colors, a picture can be painted on terra cotta as in water color work. Painting with one sweep of the brush makes a light shade. A line $^1/_{32}$ to $^1/_{16}$ inch can be made as in china painting. When the piece or panel is finished, it should be given a light brushing to bring out the high lights. If the appearance of underglaze painting is wanted, one very light coat of the white body glaze should be sprayed all over the painted ware and fired at cone 6.

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South Amboy, N. J.

MISSOURI HARD FLINT CLAY FIRE BRICK[1]

By M. E. Holmes[2] and A. J. Paul[3]

ABSTRACT

The hard flint clay obtained in the diaspore pits of Missouri, which has exceedingly low bonding properties and high shrinkage, but a P.C.E. value of cone 34, with the use of as low a percentage of flint clay grog as 20%, can be bonded into a strong brick, free of physical defects and of super-refractory quality. Excessively high forming pressure is not required. A small addition of bentonite adds materially in bonding the clay. The results of spall, hot load, cold compression, porosity, shrinkage, and reheat tests are presented.

I. Introduction

The hard flint clay of the Missouri diaspore field has a P.C.E. of cone 34, is of unusually high purity, and is remarkably uniform over the entire area. It has, however, a very high firing shrinkage and very low plasticity and bonding power.

It is not now being used without weathering or without large admixtures of bond clay. The general practice is to add 20 to 50% plastic fire clay and to make a product of cone 31 to 32 quality.

The object of this preliminary investigation is the determination of the possibilities of making, without weathering, a product in which the refractory qualities of this flint clay are sacrificed to a minimum. Such a product would be a cone 34 or near cone 34 brick, substantially homogeneous in structure.

To meet these requirements, no admixture would be preferable and only a small amount permissible.

II. Preliminary Analysis of the Problem

The defects to be overcome are those due to the stresses from the excessive shrinkage exceeding the bonding strength. The shrinkage stresses may be reduced by using a calcined flint-clay grog, and the bonding strength may be increased by bringing the grains into more intimate contact with each other and by the use of an addition agent of super-bonding properties.

The higher the forming pressure and the longer its application, the more intimate will be the grain contacts. The dry-press process is the logical forming method. Birch[4] showed that the modulus of rupture and compression strength increased with forming pressure. Dodd, Page, and

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[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Refractories Division). Received March 17, 1931.

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[3] Ceramic Engineer, Missouri Clay Testing and Research Laboratories, Rolla, Mo.

[4] *Jour. Amer. Ceram. Soc.*, **13** [4], 242; *ibid.*, [11], 831 (1930).

Netzeband[5] also have shown that increase in pressure has an important effect on the compacting of the grains into dense alignment.

Bentonite was chosen as the addition agent of superbonding properties because, as shown by Schurecht and Douda[6] and by Paul and Holmes,[7] it is of outstanding excellence in this respect. Its bonding power is so great that only a small percentage is required, thereby preserving the homogeneous character of the product.

III. Experimental Procedure

The raw clay was ground by jaw crusher and rolls to pass 10-mesh. The grog was prepared by crushing the raw clay to 4-mesh, forming dobies, and calcining to cone 16. It was then crushed and ground to pass a 10-mesh screen. The screen analyses are given in Table I.

TABLE I

SCREEN ANALYSES

	Raw clay	Calcined clay
On 10-mesh	0	0
10–20- "	41.4	42.2
20–40- "	29.0	31.9
40–60- "	9.0	10.1
60–100- "	15.8	7.8
Through 100-mesh	4.8	7.9

The bentonite was used as received.

The mixing and tempering was done in a kneading machine, five minutes of dry mixing and twenty-five minutes of wet mixing. The tempered mix was aged under damp cloths for 24 hours.

The approximate water content was determined by pressing one brick at 5830 lb. per sq. in. pressure, of mixes tempered with water ranging from 8 to 14% and determining the modulus of rupture of the brick. The results are given in Table II.

TABLE II

EFFECT OF WATER CONTENT ON MODULUS OF RUPTURE

Lot	Water content (%)	Green modulus of rupture	Dry thickness of brick (inches)
1	8	67	2.80
2	10	82	2.77
3	12	105	2.75
4	14	63	2.76

Water content of 12% seems to be the optimum for this material. With 10% or less water the brick did not become moist on the surface during compression. With 14% water the mix tended to ooze out of the ram head air-vent holes.

[5] National Brick Mfrs. Assn., *Bull.*, No. 109.

[6] *Jour. Amer. Ceram. Soc.*, **6** [8], 940 (1923).

[7] *Ibid.*, **12** [10], 676 (1929).

Standard size brick were formed on a hydraulic press. They were fired first to cone 10 in a commercial kiln, and then to cone 20 in a laboratory kiln.

With the exception of the reheat test, standard test methods were employed.

IV. Results Obtained

TABLE III

EFFECT OF GROG, BENTONITE, AND VARYING PRESSURE

Lot	Raw flint clay (%)	Calcined flint clay (%)	Bentonite (%)	Pressure (lb./sq. in.)	Firing shrinkage (%)	Fired porosity (%)	Fired compressive strength (lb./sq. in.)
A	100			5830	12.9	6.8	*11,000+
B	100			2915	12.7	9.5	*11,000+
C	100			1460	12.4	12.4	9,300
D	50	50		5830	3.5	22.1	2,900
E	50	50		2915	2.9	23.9	2,300
F	50	50		1460	2.9	24.8	2,100
G	96		4	5830	11.9	7.6	*11,000+
H	96		4	2915	12.3	7.5	*11,000+
J	96		4	1460	12.5	9.5	11,000
K	48	48	4	5830	2.8	21.9	2,200
L	48	48	4	2915	2.5	22.8	2,200
M	48	48	4	1460	2.9	24.9	2,800

* Lots A and B showed evidence of beginning to fail on the compression test at 11,000 lb. pressure, whereas lots G and H did not.

TABLE IV

VARYING GROG CONTENT WITH AND WITHOUT BENTONITE
(Pressure 5830 lb./sq. in.)

Lot	Raw flint clay (%)	Calcined flint clay (%)	Bentonite (%)	Linear firing shrinkage (%)	Fired porosity (%)	Fired compressive strength (lb./sq. in.)
A	100			12.9	6.8	11,000+
N	90	10		7.4	19.8	3,800
O	80	20		5.7	21.8	2,600
P	70	30		4.7	23.3	2,450
Q	60	40		3.8	23.9	2,460
D	50	50		3.5	22.1	2,900
G	96		4	11.9	7.6	11,000+
R	86.5	9.5	4	7.9	18.6	3,640
S	77	19	4	6.0	22.1	2,170
T	67.5	28.5	4	4.6	22.7	3,390
U	58	38	4	3.4	23.9	2,680
K	48	48	4	2.8	21.9	2,200

Two brick in each lot were tested from which these averages were obtained.
All lots were formed at 5830 lb. pressure.

The condition of the brick in regard to cracking is shown in Fig. 1.

The brick of lots A, B, and C were quite hard and strong but the edges and corners were ragged. Lot A was much superior to C. Numerous surface cracks were evident, most prominent in lot A. Large structural

cracks were evident in all and most prominent in C. Brick thickness decreases materially as the pressure is increased.

The brick of lots D, E, and F are slightly friable, the corners being more ragged than in the preceding three lots. Again, this condition improved with pressure. There is no evidence of the small surface cracks or the large structural cracks. Brick thickness decreases slightly as the pressure is increased.

The brick of lots G, H, and J are very hard and strong with excellent

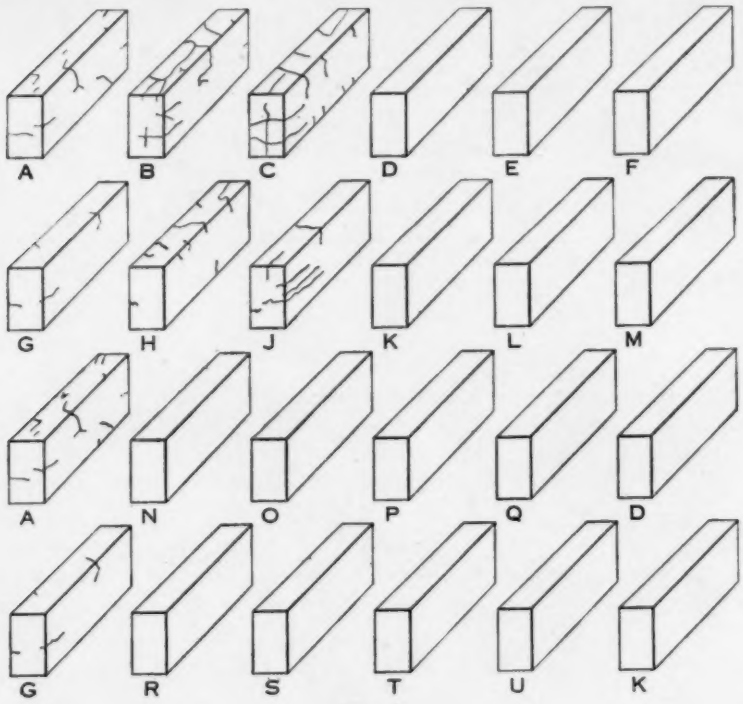

FIG. 1.

edges and corners. The surfaces are nearly free of checks and cracks. Varying the pressure had only a slight effect. Brick thickness decreases very little with pressure.

The brick of lots K, L, and M are hard and strong with good edges and corners and with no surface checking or cracking. The thickness is affected very little by pressure.

The brick of lots A, N, O, P, Q, and D have rather ragged edges and corners, increasingly so with increase in grog. Surface checking and cracking is prominent in the first three members but practically absent in the last three.

Lots G, R, S, T, U, and K have sharp corners and edges, there being only a slight tendency of the corners and edges to be less sharp with increase in grog. Surface checking and cracking are practically absent in all.

Except as already given, there was no warping, pressure lamination, or other physical defects.

V. Discussion

The data show that a well-bonded brick can be made of 100% unweathered hard flint clay.

Without grog the raw clay develops a strong bond as indicated by the compression test but the excessive shrinkage breaks down the bond as indicated by cracking. Exceedingly high forming pressure tends to reduce but fails to eliminate the cracking. Although the addition of 50% grog reduces the bonding of the individual grains, it reduces the shrinkage to the point where the bond, even at the lowest forming pressure, is not ruptured. Increasing the pressure materially improves the compression strength as it does in the case where no grog is added. It is evident, however, that with 50% grog, sound, well-bonded brick could be formed at lower pressures than any employed in these experiments.

Four per cent bentonite without grog materially improves the bond, evident mainly in the reduction of cracking, but the effect of increasing the pressure is much less than it is in the mixes containing no bentonite.

Four per cent bentonite in the 50-50 mixture of clay and grog has no important effect on bond or shrinkage cracking but the mobility it imparts to the mix permits pressing the brick with sharp corners and edges. As in the case of the other grog mixes, the pressure variation had very little effect. This group of brick represented by lots K, L, and M are superior to all the others in appearance.

As shown by the data in Table IV, the effect of increasing the amount of grog is a decrease in compressive strength, increase in porosity, decrease in shrinkage, and a decrease in cracking. Most of this effect is produced by small additions of grog, between 10 and 20%. This statement applies whether or not 4% bentonite is added. The main beneficial effect of the bentonite is the improvement in the appearance of the brick, particularly in regard to the condition of the corners and edges, although it contributes somewhat to a reduction in cracking even in the grogged mixes.

Specifications for five different mixes were drawn up and the brick were subjected to the usual tests for firebrick quality. These specifications (Table V) embody some of the combinations of the highest points of quality in the data of Tables III and IV on slag action, spalling, resistance, etc.

Lot 1 should give the lowest porosity, the greatest resistance to slag

action, and the greatest strength. It represents the maximum quality attainable without the use of grog.

Lot 2 represents a degree of quality near the maximum for the use of grog alone and also represents the most economical grog proportion for high quality. This will yield a fairly porous brick but should have high refractoriness, resistance to load at high temperatures, and vitrification on reheat.

Lot 3 represents the highest quality attainable with the materials in question. Enough grog is used for its full effect, the highest forming pressure is employed, and the optimum amount of bentonite is added.

Lot 4 differs from lot 3 only in that a relatively low forming pressure is

TABLE V

SPECIFICATIONS

Lot No.	Composition (%)	Water* used in pressing (%)	Forming pressure (lb./sq. in.)
1	96 raw flint clay 4 bentonite	11.3	5830
2	75 raw flint clay 25 flint clay grog	10.2	5830
3	48 raw flint clay 48 flint clay grog 4 bentonite	8.5	5830
4	48 raw flint clay 48 flint clay grog 4 bentonite	9.9	1460
5	77 raw flint clay 19 flint clay grog 4 bentonite	10.9	2915

* The water content was made such that the surface of the brick became slightly wetted at the pressure employed.

employed. This is intended to indicate the approximate minimum pressure that might suffice for high quality.

Lot 5 represents the minimum grog and bentonite content for fairly high quality combined with an intermediate forming pressure.

The results obtained in testing these brick, therefore, should give an indication of the maximum quality attainable by varying the factors comprehended in this investigation and should also give an indication of the extent to which the cost of manufacture might be reduced.

VI Additional Tests

Five lots of eight brick each were made according to specifications shown in Table V and fired in a commercial kiln to cone 16. The brick were then subjected to the A.S.T.M. load under heat test, A.S.T.M. spalling resistance test, and to a special reheat test at 1550°C for five hours.

The data of Table VI show that brick can be made of the materials in question at moderate forming pressures and cone 16 firing, having unusually

high resistance to hot load and to vitrification in the high-temperature reheat test.

Hot load test subsidence of only a fraction of that of average No. 1 fire brick was obtained. The lots with the higher grog contents and those formed at highest pressures gave the best hot load test, but excellent results were obtained with as little as 25% grog and forming pressures of 1400 lb. per sq. in. There is no indication of any harmful effect from the use of 4% of bentonite.

Decrease in porosity on the high-temperature reheat test ranged from 11.9 to 60%, the latter being for those containing no grog. A maximum decrease of 22.7% was obtained in those containing grog. Samples of five brands of No. 1 fire brick reheated at the same time along with these experimental brick showed porosity decreases ranging from 41.1 to 73.1%.

The fire brick made of raw clay and bentonite have very high compres-

TABLE VI

RESULTS

Lot No.	Linear firing shrinkage (cone 16) (%)	Linear shrinkage (%) in load test (1315°C 1½ hrs.)	No. of dips in 1350°C 2 in. water-dip spall test Loss (%)	Fired Apparent Porosity		Decrease in apparent porosity in reheat (%)	Linear shrinkage in reheat test (%)	Compressive strength (fired lb./sq. in.)
				Before reheat (cone 16)	After reheat (1550°C 5 hrs.)			
1	10.3	1.40	20 dips no loss	12.7	5.1	60.0	2.1	10,400
2	3.6	1.15	13 " 20% "	25.4	21.1	17.0	1.45	2,280
3	1.8	0.90	16 " " "	24.2	18.7	22.7	2.0	2,780
4	1.7	0.71	15 " " "	26.8	23.6	11.9	1.2	2,340
5	3.9	1.75	11 " " "	25.2	21.0	16.7	1.4	2,270

The results are the averages of two specimens used in each test.

sion strength. The addition of the grog, whether it be as low as 20% or as high as 50%, with or without bentonite reduces the compression strength to about that of ordinary No. 1 fire brick.

The noteworthy effect of the grog in reducing firing shrinkage is shown by the figures in column 2.

The brick are not of superquality in the water-dip spall test. Lot No. 1 which contained no grog but 4% bentonite, and which gave by far the highest compression strength, gave the best spall test results. This emphasizes the importance of a strong bond for resistance to spalling. Although this lot gave no loss in 20 dips its condition at the end of 20 dips was such as to indicate rather rapid spalling from then on. The other lots ranged from eleven to sixteen dips for the 20% loss. This is much inferior to that of best quality No. 1 fire brick. In view of the high quality of these brick in other respects it would be highly desirable to obtain air-cooled spall test results or simulated service test results because it is known that in comparing two different kinds of brick the water-dip spall results are sometimes wholly misleading. Such tests would bring out the quality of these

brick in regard to mechanical and structural spalling as well as their resistance to thermal spalling.

The brick of all lots were sound, well-bonded, free of cracks, substantially free of surface checking, and had sharp well-formed corners and edges.

VII. Summary

Strong, well-bonded brick of super-refractoriness, free of laminations, cracks, or other physical defects, can be made by the dry-press process and a cone 16 firing, of the hard flint clay of the Missouri diaspore field without the addition of any other material and at only moderately high forming pressures. The calcination of a small percentage of the mix meets the requirements.

The indications are that it is difficult or impossible to develop a bond sufficiently strong to withstand the shrinkage stresses and thereby to avoid cracking when the raw clay is used without treatment or addition agents, even though forming pressures as high as 5800 lb. per sq. in. and a cone 20 firing are employed. (Lots A, B, and C.)

The addition of 50% flint clay grog reduces the shrinkage as much as 75%, increases the porosity as much as 60%, and although it reduces the crushing strength very much, it eliminates all cracks. Increasing the pressure from 1460 to 5830 lb. per sq. in. is of negligible consequence on mixes containing 50% grog. (Lots D, E, and F.)

Although the effect of the grog increases with amounts of grog up to 50% most of the effect when pressed at 5830 lb. per sq. in. is obtained with amounts as low as 10%. More than 20%, however, is required to eliminate all surface checking. (Lots A, N, O, P, Q, and D.)

The probabilities are that pressures at least as low as 1400 lb. per sq. in. may be satisfactory with grog contents somewhat higher than 20%.

The effect of adding 4% bentonite, under the conditions here employed, to raw clay mixes, was a slight increase in crushing strength, decrease in porosity at the lower pressures, substantial reduction of cracking, and the development of a better ring, and stronger, sharper corners and edges. The effect upon shrinkage is negligible. The lower porosity obtained with bentonite at the lowest forming pressure indicates that it imparts a mobility to the mix which might be very important at pressures much lower than 1460 lb. per sq. in. (Lots G, H, and J.) It must be remembered, however, that 4% bentonite lowers the P.C.E. about one cone.

When grog is used, the effect of the bentonite is limited to a reduction in cracking and an improvement of the condition of the corners and edges.

Five additional lots of brick, prepared after preliminary data were obtained, were subjected to hot load, spalling, and reheat tests. These brick were formed at pressures ranging from 1460 to 5830 lb. per sq. in. and were fired at cone 16. The subsidence in hot load test ranged from 0.71

to 1.75% or only a fraction of that of No. 1 fire brick. In a reheat test at 1550°C for five hours, porosity decreases ranging from 12 to 60% were obtained, compared with 41 to 73% for five different brands of No. 1 fire brick tested at the same time. The 60% reduction in porosity was obtained with the non-grogged mixes, the maximum reduction for the grogged mixes being 23%. Water-dip spall test results ranging from 20% loss in 11 dips to no loss in 20 dips were obtained.

The indications are that these brick are of super-quality in P.C.E., resistance to load at high temperature, and vitrification in high-temperature service. The water-dip tests indicate only medium resistance to thermal spalling.

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RESEARCHES IN DRY-PRESS REFRACTORIES, III. THE EFFECT OF VACUUM ON THE UNFIRED PROPERTIES OF SOME DRY-PRESS REFRACTORY BATCHES[1]

By W. C. Rueckel[2]

ABSTRACT

A series of tests on several typical refractory bodies are presented. These include data showing the effect of varying the amount of vacuum, and its length of time of application on the green and dry properties. The limits of pressure attainable with a mechanical press are also discussed.

I. Introduction

Results previously reported in this study indicate that pressures of 2500 to 5000 lb. per sq. in. materially improve most of the qualities of a refractory brick. These results as reported by Birch[3] were obtained on a hydraulic press. Tests which were made to determine the possibility of obtaining equally high pressure effects in a mechanical press are here presented.

Data showing the amount and duration of vacuum necessary to eliminate pressure cracking and the effect of various degrees of vacuum on the green and dry properties of dry-pressed brick are also presented.

II. Hydraulic *vs.* Mechanical Pressing

The impracticability of direct-pressure measurement in mechanical presses necessitates a correlation of pressure effect and bulk density. Brick were formed in the mechanical press with a sufficient weight of clay in the mold to insure a maximum bulk density. When a commercial cycle of pressing (8 sec.) is used, however, they crack badly. The cycle was then lengthened to give uncracked brick with a maximum density. The materials and conditions of forming employed in the mechanical press were then exactly duplicated in the hydraulic press.

To determine the maximum pressure obtainable on a mechanical press of the type used at a majority of the refractories plants, a test was run with the four mold boxes filled. The pressing cycle ($2^1/_4$ min.) was found to permit maximum pressure effect without injury to the press, and the four brick were free from cracks. The remainder of the brick were pressed at the same cycle with but one mold box filled at each cycle.

Table I gives the physical properties and conditions of the forming of the hydraulically and mechanically pressed brick.

NOTE: The power required to operate the mechanical press was found to be 9.9 h.p. at eight cycles per minute with the four mold boxes filled.

[1] Presented at the Annual Meeting, AMERICAN CERAMIC SOCIETY, Cleveland, Ohio, February, 1931 (Refractories Division).

[2] Research Engineer, O.S.U. Engineering Experiment Station, Roseville, Ohio.

[3] R. E. Birch, "Researches in Dry-Press Refractories, Parts I and II," *Jour. Amer. Ceram. Soc.*, **13** [4], 242; *ibid.*, [11], 831 (1930).

The hydraulic pressure required to obtain brick of the same bulk density using the same cycle is assumed to be the pressure attained in the mechanical press.

The close agreement of properties warrants the assumption that the batches receive equal pressure effects in both presses. The hydraulic forming requires a pressure of 6200 lb. per sq. in. This figure would appear

TABLE I

PROPERTIES OF BRICK FORMED IN THE HYDRAULIC AND MECHANICAL PRESSES

	Flint Fire Clay 70% Plastic Fire Clay 30% Type Press	
	Mechanical	Hydraulic
Green bulk density (lb./cu. in.)	0.0846	0.0844
Green modulus of rupture (lb./sq. in.)	75.8	150.0
Drying shrinkage (%)	0.42	0.21
Dry modulus of rupture (lb./sq. in.)	170.5	180.3
Dry bulk density (lb./cu. in.)	0.0805	0.0808
Fired modulus of rupture (lb./sq. in.)	1790.0	1625.0
Firing shrinkage (%)	5.78	7.22
Fired bulk density (lb./cu. in.)	0.0832	0.0831
Spalling (thermal)	23 dips	24 dips
Fired porosity (%)	14.1	14.5
Cycle	2 min 15 sec.	2 min. 15 sec.
Power required to press (h.p.)	8.5	2.14
Water content	5.82	5.80
Pressure (lb./sq. in.)	6200	6200
P.C.E.	30	30

to indicate the possibility of safe mechanical pressing at 5000 lb. per sq. in., when a long cycle, such as was used in the tests, is employed. A necessary requirement is that the press be sufficiently powered.

III. Effect of Evacuation of Mold Boxes

As previously stated, an obstacle to the use of high forming pressures with certain clays is cracking. Birch[3] found that pressure cracking can be eliminated by evacuating the mold boxes.

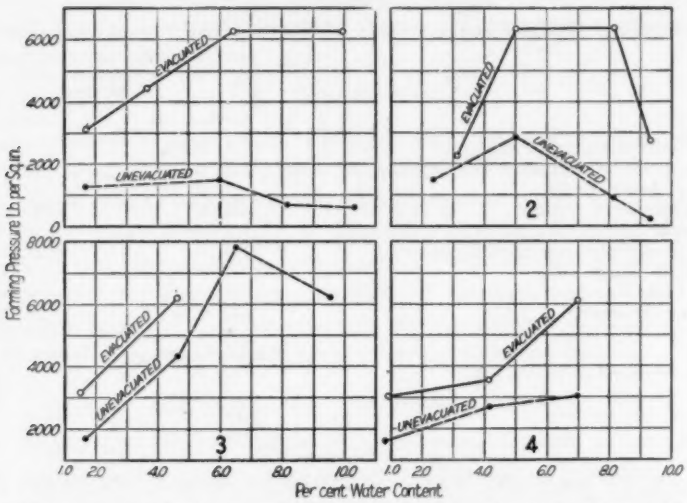
A study was made of the effect of varying the degree and the duration of vacuum on the physical properties of the brick produced. The batches selected for this study were ground to pass a 20-mesh sieve and tempered with water. With variations of water content, the limits of pressure attainable without cracking were obtained, with and without evacuation. Figures 1 to 4 indicate the results in graphic form.

The effect of evacuation is especially noticeable on plastic fire clay because of the low pressure cracking limits imposed by the clay. On the other hand, in the case of a batch composed of 70% flint and 30% plastic fire clay when the water content is closely controlled, evacuating the mold box is hardly necessary.

From these data it can be seen that evacuation also widens the range of moisture content permissible without developing pressure cracks.

To determine the amount of vacuum required to eliminate pressure cracking and the length of time it should be applied, tests were made on the 70% plastic and 30% flint fire clay and 70% flint and 30% plastic fireclay batches.

The two batches were pressed at 1550 lb. per sq. in., 3550 lb. per sq. in., and 5550 lb. per sq. in., with no vacuum and vacuums of one-third and two-



FIGS. 1–4.—Maximum pressure attainable without cracking. (1) 100% plastic fire clay. (2) 70% plastic and 30% flint fire clay. (3) 70% flint and 30% plastic fire clay. (4) 100% flint fire clay.

thirds atmosphere, respectively (25 cm. and 50 cm. approximately), the moisture content being nearly constant.

To make the results of practical value, the duration of vacuum was limited wherever possible to 5 seconds.

The results are shown in Tables II, III, and IV.

TABLE II

CONDITION OF THE BRICK WHEN FORMED

	Forming Pressure					
	70% Plastic 30% Flint			70% Flint 30% Plastic		
Vacuum applied	1550 lb./-sq. in.	3550 lb./-sq. in.	5550 lb./-sq. in.	1550 lb./-sq. in.	3550 lb./-sq. in.	5550 lb./-sq. in.
None	O.K.	Cracked	Badly cracked	O.K.	O.K.	Cracked
25 cm.	O.K.	O.K.	Slightly cracked	O.K.	O.K.	O.K.
50 cm.	O.K.	O.K.	O.K.	O.K.	O.K.	O.K.

The preceding tables show that the use of vacuum is particularly effective on the high plastic fireclay batch. A vacuum of 25 cm. is sufficient to eliminate pressure cracking with the exception of the high plastic fireclay

batch formed at 5550 lb. per sq. in. The duration of vacuum necessary in this case is prohibitive. A vacuum of 50 cm., however, permits a much shorter time of application.

Figures 5 and 6 show the mold box prepared for evacuation. The vacuum is effective around the peripheries of the plates *A* and *B* as shown by the small arrows. Figure 7 shows the cross-section of three brick, two of which were pressed in an evacuated mold box.

Figure 8 is inserted to illustrate the effect of the length of the cycle of pressing in the elimination of pressure cracks.

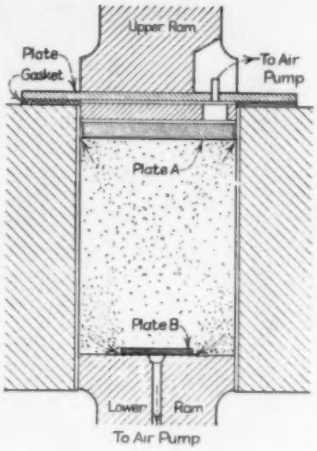


FIG. 5.—Cross-section of mold box, showing method of evacuation.

IV. Conclusions

(1) Pressures of 5000 lb. per sq. in. can be obtained in the type of mechanical presses now largely used in refractory plants. Such pressures cannot be employed, however, except over a long cycle due to pressure cracking.

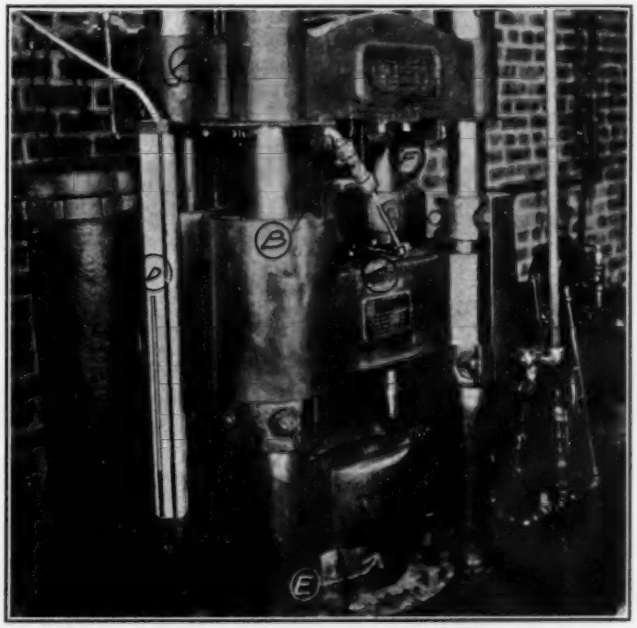


FIG. 6.—Experimental press equipped for forming brick in vacuum. *A*, vacuum pump; *B*, dust filter; *C*, pipe to mold; *D*, vacuum gage; *E*, hydraulic ram; *F*, hydraulic pressure gage.

Table III

Properties of High Plastic Fireclay Batch

Composition { Plastic fire clay 70% / Flint fire clay 30%

	Forming Pressure 1550 lb./sq. in.			3550 lb./sq. in.			5550 lb./sq. in.		
Vacuum applied (cm.)	None	25	50	None	25	50	None	25	50
Water content (%)	6.10	6.10	5.82	5.82	5.82	6.20	6.10	6.10	6.10
Green bulk density (lb./cu. in.)	0.0777	0.0777	0.0778	0.0816	0.0813	0.0819	0.0795	0.0836	0.0839
Green modulus of rupture (lb./sq. in.)	43.2	44.6	43.2	74.8	79.8	85.4	83.5	128.3	98.12
Dry bulk density (lb./cu. in.)	0.0729	0.0743	0.0733	0.0765	0.0774	0.0772	0.0778	0.0812	0.0793
Dry modulus of rupture (lb./sq. in.)	77.2	89.0	108.2	143.3	202.2	242.8	220.1	276.0	284.0
Cycle (seconds)	20	15	26	25	23	26	31	57	33
Length of evacuation (seconds)		10	5		5	5		35	5
Vacuum drop (cm.)		2	28		13	34		10	31

Table IV

Properties of High Flint Fireclay Batch

Composition { Flint fire clay 70% / Plastic fire clay 30%

	Forming Pressure 1550 lb./sq. in.			3550 lb./sq. in.			5550 lb./sq. in.		
Vacuum applied (cm.)	None	25	50	None	25	50	None	25	50
Water content (%)	5.2	5.2	5.2	5.2	5.2	5.2	5.0	4.8	4.8
Green bulk density (lb./cu. in.)	0.0766	0.0767	0.0765	0.0810	0.0807	0.0805	0.0823	0.0823	0.0819
Green modulus of rupture (lb./sq. in.)	31.76	34.60	59.62	63.20	62.88	60.74	81.38	86.80	79.40
Dry bulk density (lb./cu. in.)	0.0764	0.0733	0.0731	0.0794	0.0775	0.0771	0.0790	0.0790	0.0787
Dry modulus of rupture (lb./sq. in.)	75.76	84.48	79.92	157.5	164.1	159.3	185.6	208.8	200.0
Cycle (seconds)	24	17	25	24	20	24	25	24	30
Length of evacuation (seconds)		5	5		5	5		5	5
Vacuum drop (cm.)		17	34		15	40		17	38

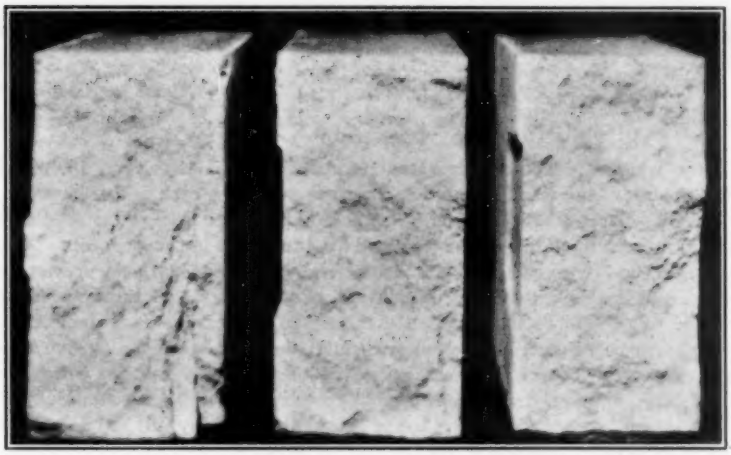


FIG. 7.—Brick pressed at 3550 lb./sq. in. Left, pressed without vacuum; middle, 25 cm. vacuum; right, 50 cm. vacuum.

Just how much the cycle can be speeded up when the mold box is evacuated is to be the subject of a future study.

(2) Evacuation of the mold boxes raises the pressure cracking limits of refractory clays. The effect is more pronounced on the plastic than on the nonplastic clays.

(3) An evacuation can be effected, in a commercial cycle of pressing, to eliminate pressure cracking on the batches studied. This indicates the possibility of forming refractories at high pressures without using a commercially prohibitive cycle of operation.

(4) Improvement is more noticeable on the dry than on the green properties of the brick and parallels the elimination of pressure cracking.

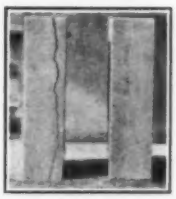


FIG. 8.—Effect of length of cycle of pressing. Pressure the same on both brick. Left, cycle of 15 seconds; right, cycle of 60 seconds.

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THE RESISTANCE OF SINGLE CLAY BODIES TO THE ACTION OF STEAM[1]

By C. L. Deeds

ABSTRACT

Twelve whiteware bodies were made, consisting of 51.41% clay, 10.69% North Carolina feldspar, and 37.9% flint, one clay being used in each body. Twelve clays were studied. The specimens made from these bodies were fired in the regular tunnel bisque kiln to cone 9, glazed on one side, and fired to cone 4 in the glost kiln. The trial pieces were then subjected to the autoclave test, with the steam at a pressure of 100 pounds per square inch, maintained for a period of 3 hours. Of three American ball clays none was found to have caused crazing. In the case of four domestic kaolin bodies, one crazed in part, two were noncrazing, and one shivered. Of five imported kaolins, one of the bodies was noncrazing. While lower absorptions bring about a craze-resisting condition, it was shown that of two single clay bodies with practically the same absorption, one may resist the steam action and one may not. The structure of the clay is an important factor in this connection.

I. Introduction

In the literature dealing with the action of steam on glazed bodies, the distinction between the behavior of different clays has not been developed. It seemed to be of interest to show to what extent the source of the clay substance affects the volume changes brought about by the action of the steam.

II. The Investigation

The present experiment consisted in the preparation of twelve bodies having the following composition:

	(%)
Clay	51.41
N. C. feldspar	10.69
Flint	37.90

In each body one clay was used as the source of the clay substance and twelve clays were thus introduced. The feldspar was of the type carrying 68% of silica, 18 alumina, 10 potash, and 3 soda. The flint was from the Pennsylvania district.

The bodies were prepared by blunging and lawning in the usual way. They were pressed into disks $3^1/_4$ inches in diameter and $^3/_8$ inch in thickness. The specimens were bisque fired to cone 9 in a direct-fire tunnel kiln. They were then glazed on one side, using a typical whiteware, fritted glaze. The glost firing was carried to cone 4 again in a tunnel kiln.

Eighteen disks were made from each body, of which two were used for the determination of the absorption. Care was taken to fire the specimens together in the same sagger.

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (White Wares Division).

When taken from the kiln the glazed disks were at once subjected to the autoclave test, in which a steam pressure of 100 lb. per sq. in. was maintained for three hours. The time required to bring up the steam pressure to the required point was about 2 hours, a natural gas burner being used.

III. Results

The results obtained are compiled in the following table.

Clay	Absorption (%)	Thickness of fused glaze (mm.)	Disks used	Number crazed
Ky. ball clay (*a*)	2.70	0.15	16	None
" " " (*b*)	4.04	0.15	16	None
" " " (*c*)	1.79	0.10	16	None
N. C. kaolin	15.09	0.125	14	4
Fla. "	13.05	0.15	16	None
Ga. " (*a*)	13.92	0.10	16	None
Ga. " (*b*)	17.86	0.162	15	15 shivered
Imported " (*a*)	5.48	0.10	16	None
" (*b*)	9.78	0.113	16	16
" " (*c*)	13.01	0.15	16	16
" " (*d*)	7.76	0.125	14	6
" " (*e*)	11.84	0.27	15	11

The specimens were examined for crazing as soon as they had cooled down sufficiently. The thickness of the fused glaze was measured by means of the micrometer microscope on fractured pieces.

(1) Domestic Clays It is a curious fact that none of the bodies made with American clays showed any decided crazing, indicating rather the reverse tendency in the case of the Georgia kaolin (*b*) where all of the test pieces were found to have shivered. This is an example of how two clays of the same type may behave differently, but the kaolin (*b*) has a considerably higher absorption than (*a*) and also a thicker layer of glaze. The shivering of (*b*) took place all around the glazed edge of the trial pieces. This would indicate a higher coefficient of thermal expansion of this body and hence a difference in structure from (*a*).[2]

(2) Imported Clays All but one of the imported kaolins were found to have crazed in the steam treatment. It should be noted, however, that with kaolin (*d*) only 6 out of 14 test pieces had crazed, and that the kaolin (*e*) had a heavy coating of glaze, the thickest of any of the bodies. This would necessarily make the test conditions very severe.

(3) General Statement The fact should be emphasized that the behavior of these materials in single clay bodies

[2] This result was due to the fact that clay (*a*) was in the crude state when received, while (*b*) had been put through a washing process at the mine. It is possible that the crude clay may carry more clay substance than the washed material, contradictory as this may sound, but it is not an uncommon practice to use several strata of clay for washing, one of which might carry a higher amount of fine siliceous matter or other mineral residue of great fineness.

does not mean that they would be detrimental in regular bodies which invariably contain a considerable amount of ball clay. Again, if these single clay bodies had been fired to a lower absorption they would undoubtedly have shown a better resistance to the treatment to which they were subjected.

It is evident that the results obtained do not suffice to establish any relation between the absorption or porosity and the behavior in the steam test, but they confirm the observation that with decreasing porosity the resistance to the action of steam increases. At the same time, another fact stands out, namely, that each clay has its own characteristic in this respect, independent of the porosity. It would appear that the significance of the individual clay structure should be considered, by virtue of which certain clays resist the steam action better than others. Thus, in this series of tests two clay bodies have more than 13% absorption and yet they resisted the test conditions successfully, while other bodies with lower absorption have failed. This is true in spite of the fact that the more porous bodies, as a rule, carry a heavier coating of glaze than the denser ones.

In steam tests of glazed products the thickness of the glaze should be considered inasmuch as it is not quite fair to compare two products without considering the influence of a heavier glaze covering.

The nature of the structural differences which cause the different degrees of resistance to the action of steam can only be conjectured, but it would seem important that the idiosyncracies of the various types of clay be considered from this standpoint.

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SHRINKAGE OBSERVATIONS ON A PORCELAIN BODY[1]

By M. H. Hunt

ABSTRACT

Data on the shrinkage of large porcelain tubes and rods are given. The shrinkage of the test samples varies considerably not only in different sections of the same pieces, but among samples taken from tubes and rods formed in various ways.

I. Introduction

Nearly all porcelain insulators are used with hardware parts either cemented or fitted to the porcelain, the complete assemblies falling within narrow limits of dimensional accuracy.

In some cases it is difficult to calculate the dimensions to make a porcelain shape in the plastic or semiplastic shape to arrive at the required fired dimensions. The usual total shrinkage of $^5/_{32}$ inch per 1 inch from plastic to fired is sufficiently accurate for the porcelain body for most purposes. There are some shapes, however, which require more precision, in which case an insulator is turned, using the standard $^5/_{32}$-inch shrinkage. It is then fired and suitable adjustments in insulators subsequently turned are made when necessary. The general class of insulators known as tubes are an example of this method.

No mold equipment of a permanent nature is required for these insulators, the method of manufacturing being to pug a cylindrical blank of suitable bore, diameter, and length and then to turn this blank to set dimensions after drying to a leather-hard or bone-dry stage.

The observations forming the basis for this paper were made during a study of the shrinkage behavior of some of these tube blanks, as well as some solid pugged blanks designated as rods. Cast tubes and rods together with several methods of forming have also been included.

II. Preparation of Test Samples

The test pieces used were cut from standard insulator blanks as formed in the shop. Shrinkage marks were immediately inscribed after forming, air dried at room temperature, and finally dried at 105°C and fired in a tunnel kiln at cone 10.

III. Results

Figure 1 shows some of the test pieces with the circumscribed lines used for the shrinkage measurements, the numbers on the photographs corresponding to the curve numbers.

Curves in Fig. 2 show that the linear shrinkage increases from the bore diameter to the outside diameter. In the case of these pugged tubes, the

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (White Wares Division).

total shrinkage seems to decrease with increasing wall thickness, No. 20 having a wall thickness of 1.375 inches and a maximum shrinkage of 17.7%, and No. 16 a wall thickness of 4.5 inches and a maximum shrinkage of 15.6%. The differential shrinkage, however, is somewhat less in No. 20 than in No. 16. The general shrinkage behavior is nearly the same in all of these samples, as evidenced by the general contour of the curves.

FIG. 1.

Figure 3 gives the results obtained when the tubes were made by throwing (No. 4) and extruding[3] (No. 28).

The thrown tube shows less difference in shrinkage between the bore diameter and the outside diameter than the extruded tube. The extruded tube behaves about as the average of the pugged tubes shown in Fig. 1.

Figure 4 records the results obtained with rods of various diameters made by pugging, throwing, extruding, and casting. It is interesting to note the dissimilarity between curves No. 26 and No. 8, the former being a pugged rod and the latter a thrown rod, both about the same diameter.

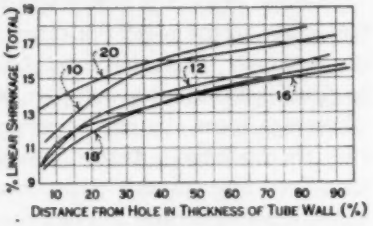

FIG. 2.—Pugged tubes: No. 10, $1^{5}/_{16}$-in. bore, $4^{3}/_{16}$-in. outside diameter, wall thickness 1.437 inches; No. 12, $2^{5}/_{16}$-in. bore, $7^{1}/_{2}$-in. outside diameter, wall thickness 2.594 inches; No. 16, 3-in. bore, 12 in. outside diameter, wall thickness, 4.5 in.; No. 18, $3^{3}/_{16}$-in. bore, $8^{3}/_{8}$-in. outside diameter, wall thickness 2.594 in.; No. 20, $^{7}/_{16}$-in. bore, $3^{1}/_{16}$ in. outside diameter, wall thickness 1.375 in.

The thrown tube shown in curve No. 4 (Fig. 3), shows a greater differential shrinkage than the thrown rod shown in Fig. 4.

The cast rod, curve 54, indicates quite a uniform shrinkage, regardless of its large diameter.

Comparing curve 28 (Fig. 3) with curve 22 (Fig. 4), it is noticed that the extruded rod shrinks more uniformly than the extruded tube.

Figure 5 shows the results obtained on cast rods of varying diameters.

Figure 6 gives the results obtained with three cast tubes and one pugged

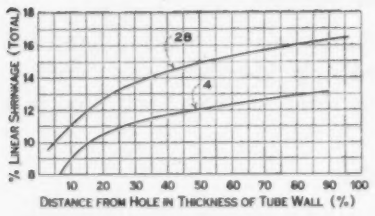

FIG. 3.—Thrown tube: No. 4, $1^{5}/_{8}$-in. bore, $7^{5}/_{8}$ in. outside diameter, wall thickness, 3 in.; Extruded tube, No. 28, $2^{5}/_{8}$ in. bore, $8^{1}/_{2}$ in. outside diameter, wall thickness 2.937 in.

[3] The extruded tube was made by first pugging the clay body into a large cylinder and then by a piston forcing it out through a die. The bore was made by extruding the column over an outside supported central member.

tube in which holes were punched to facilitate the drying of the center section.

In general, the cast tubes show a greater differential shrinkage than the cast rods. The punching of holes in tube No. 40 seems to have increased the differential shrinkage rather than to have decreased it, as observed by comparing this curve with curve 12 (Fig. 2), which is a tube of about the same diameter.

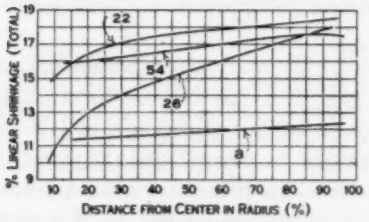

FIG. 4.—Thrown rod: No. 8, $6^{3}/_{8}$ in. diameter; extruded rod, No. 22, $2^{15}/_{16}$ in. diameter; pugged rod, No. 26, $6^{9}/_{16}$ in. diameter; cast rod, No. 54, 12 in. diameter.

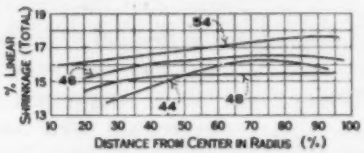

FIG. 5.—No. 44, cast solid, $3^{3}/_{4}$ in. diameter; No. 46, cast solid, $5^{1}/_{8}$ in. diameter; No. 48, cast solid, $7^{3}/_{8}$ in. diameter; No. 54, cast solid, 12 in. diameter.

Figure 7 is made up of three curves showing the behavior of a wad clay mixture and a wedged and pugged porcelain body rod hammered into a mold by hand and perforated with $^{9}/_{16}$-inch holes for better drying conditions. The circumscribed circles were made after punching the holes.

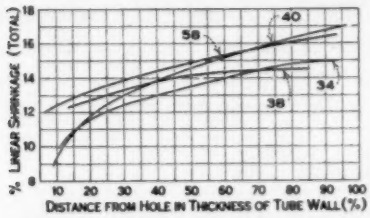

FIG. 6.—Cast tube: No. 34, $2^{3}/_{8}$ in. bore, $7^{5}/_{16}$ in. outside diameter, wall thickness 2.468 in.; cast tube, No. 38, $1^{11}/_{16}$-in. bore, 5 in. outside diameter, wall thickness 1.656 in.; pugged tube, No. 40, $1^{1}/_{2}$-in. bore, $7^{1}/_{2}$ in. outside diameter with $^{9}/_{16}$-in. holes punched for drying; cast tube, No. 58, $4^{1}/_{2}$-in. bore, 12 in. outside diameter, wall thickness 3.75 in.

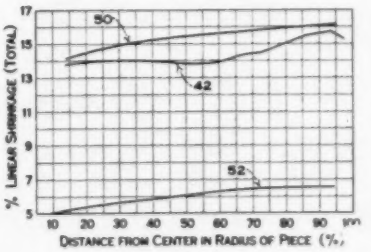

FIG. 7.—Solid pug, No. 42: hammered into mold, $7^{1}/_{2}$ in. diameter, $^{9}/_{16}$-in. diameter holes for drying; wedged clay, No. 50, hammered into mold, $7^{3}/_{8}$ in. diameter; wad clay, No. 52, hammered into mold, $7^{3}/_{8}$ inch diameter.

IV. Conclusions

In general, the solid pugged blanks (*i.e.*, the rods) show more uniform shrinkage behavior than do the tubes, although the cast rods as a class are the most uniform.

The thrown rod presents almost a straight line, whereas the thrown tube has a differential shrinkage of 5%. The thrown samples show considerably less total shrinkage than any of the other methods of forming, only part of which is due to the fact that the clay used for this purpose contains a somewhat smaller percentage of moisture.

It is well known that the shrinkage of a clay body alters somewhat, depending upon the method of formation, *i.e.*, if a clay test bar is stretched previous to inscribing shrinkage marks, a higher shrinkage will result, whereas if the bar is compressed, a reduction in normal shrinkage will result. The reason for the behavior of the various tubes and rods, as shown by the curves (Figs. 2 to 7) is due no doubt to a combination of forming conditions, including both tension and compression in varying degrees, depending upon the size of the forming tools.

In the cases where the clay body was worked by throwing, wedging, or tamping into a mold, the shrinkages were quite uniform, which is also the case where a portion of a pugged rod is used for forming an insulator by any one of the pressure methods.

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MECHANICS OF ENAMEL ADHERENCE, I

Technique of Preparing Enamel Metal Sections for Microscopic Analysis[1]

By J. O. Lord and W. C. Rueckel

ABSTRACT

The customary method for preparation of metallographic specimens is described, with modifications necessary to adapt the method to preparation of sections of enameled metal. The modifications noted are (1) cutting the section at an angle to the plane of the sheet so as to expose a wider band of enamel and metal, (2) maintaining the direction of grinding and polishing so that the action is from enamel to metal portions of the surface at all times, and (3) using a paraffin covered wheel with levigated alumina as a polishing medium, in order to secure a flat surface.

The use of the metallographic microscope in the examination of these specimens is described with some conclusions regarding the false appearances of lines of contact, etc., due to improperly prepared specimens.

I. Introduction

A brief description of the method of preparing specimens for microscopic examination is presented in this paper, which is one of a series of investigations dealing with the nature, causes, and mechanics of the adherence of enamels to metals. Some possible misinterpretations and points of value in the use of the microscope will be given.

II. Cutting Out Samples

A representative section was sawed from the piece with a hack saw. This was accomplished without chipping the enamel from the steel by using two wooden blocks to support the specimen while sawing (see Fig. 1).

III. Grinding

This specimen, approximately $^1/_2$ by 1 inch, was placed against a silicon carbide grinding wheel in such a way that a section through the piece was ground smooth. It is desirable that this section be a beveled edge rather than square so as to display a wider band of both enamel and steel (see Fig. 2).

IV. Mounting

After marks made by sawing the specimen were ground smooth, the specimen was mounted in a small cylinder with sealing wax. This cylinder was simply a $^5/_8$-inch pipe and the purpose of mounting the specimen in

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Enamel Division). Received March 10, 1931.

it was to hold the specimen steady during the remaining grinding and polishing operations[2] (see Fig. 3).

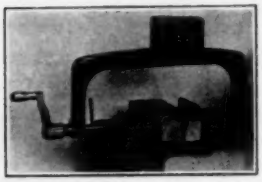

FIG. 1.

Irregularities in filling the cylinder with wax made it necessary to re-grind the specimen after mounting. From the latter, the grinding proceeded successively on emery paper, grades 0 to 0000. In each case the various grades of paper were used until the scratches and striations caused by the preceding operations were eliminated. It should be noted that the cutting is from the enamel to the metal to prevent chipping at the line of contact.

V. Polishing

The actual polishing is accomplished by the use of levigated alumina on a paraffin wheel and jeweler's rouge on a wheel covered with a very good grade of broadcloth. The paraffin wheel is prepared by pouring molten paraffin on the surface of a metal polishing wheel and smoothing the surface with a straight edge (see Fig. 4). The back of a hack saw blade is a satisfactory straight edge.

FIG. 2.

FIG. 3.

Considerable time should be spent on polishing with the levigated alumina and the rouge. As in the case of grinding, during the polishing the specimen should always be held so that the wheel polishes from the enamel to the steel.

The finished specimen should have a high polish to reflect the vertical illumination of the microscope. It should also be free from scratches which will obliterate the crystal structure of the steel on etching.[3]

FIG. 4.

VI. Microscopic Examination

To examine the specimen properly under the microscope, it must first be leveled (Fig. 5) so that all of the

[2] The use of sealing wax as a mounting medium is not ideal but it has some advantages over sulphur, Wood's metal, dental cement, plaster, and Portland cement, all of which were tried. The method of preparing the specimen for microscopic examination is similar to methods of preparing metallographic specimens. See R. B. Guthrie, "Sample Preparation for High Power Micrography," *Trans. A.S.S.T.*, **25**, 337–41 (1925) and R. B. Guthrie and J. A. Comstock, "Automatic Preparation of Metallographic Samples," *Metals and Alloys*, January, pp. 727–30 (1930).

[3] Where attention is directed chiefly to the line of contact between enamel and metal it is not so essential that the surface be free from scratches. In fact, it is better to dispense with the rouge treatment in this case.

surfaces will reflect the light equally. Figure 6 shows a type of microscope suitable for magnifications up to 400 or 500 diameters. The two photographs of the same specimen, Figs. 7*a* and 7*b*, were taken at 100 diameters and 1000 diameters, respectively, and show something of the relative amount of detail resolved at these magnifications.

FIG. 5.

FIG. 6.

Increasing the magnification of a specimen increases the amount of detail that can be observed but decreases the field of vision. In general, magnifications above 500 diameters have been found to be empty magnifications and the field of vision diminished to such an extent that only in exceptional cases has it been advisable to use the higher magnifications.

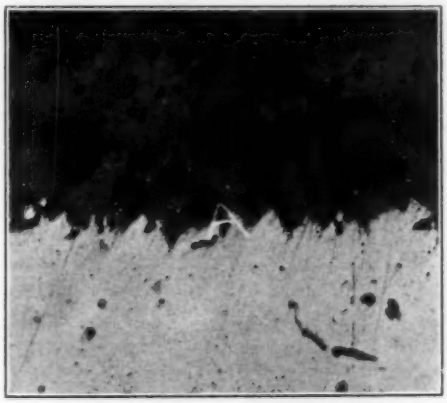

FIG. 7*a*.

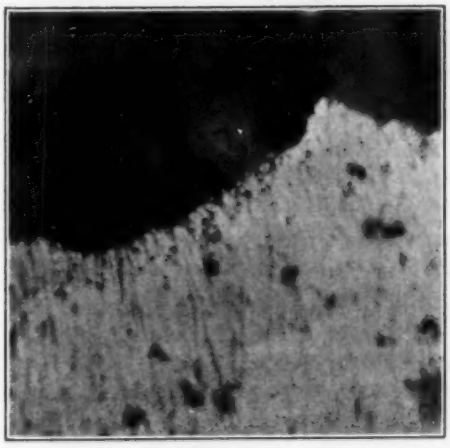

FIG. 7*b*.

The line of contact between the enamel and steel and the bubble structure of the enamel are the main factors to be observed. Certain illusions arise, however, the cause of which must be fully understood before an intelligent interpretation of the microscopic appearance of the specimen can be made.

The first point to be considered is the method of illumination. The source of light being at some distance in front of the microscope, the rays are directed onto a 45° mirror in the microscope tube which reflects them down through the objective by which they are brought to a focus on the specimen. The polished surface of the specimen reflects them back past the mirror (or

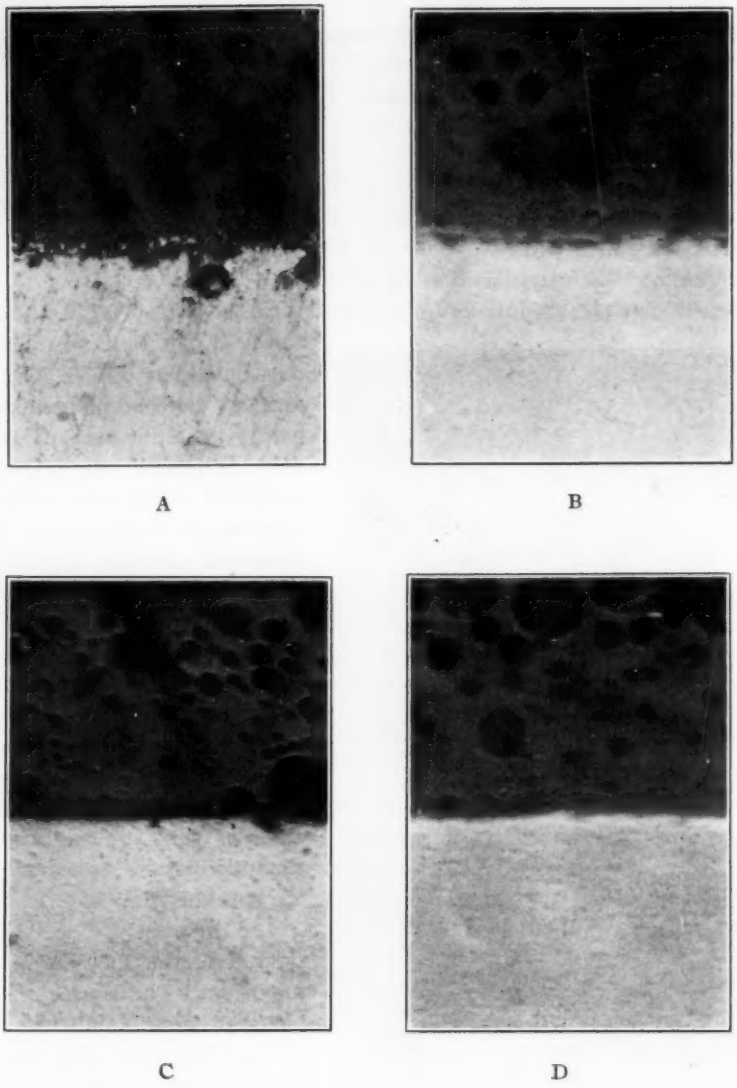

FIG. 8.—(A) 350× finished on a paraffin wheel; line of contact well defined.

(B) 120× finished on levigated tripoli and rouge, cloth covered wheels; objective too far from the surface. Note the Becke line effect.

(C) Same as B, approximately correct focus; dark band in contact region due to sloping surface of enamel.

(D) Same as B; objective too near the specimen; rounded edge of the metal appears bright.

through it if it is made of clear glass and not silvered as is usually the case) and the light enters the eyepiece of the microscope. From this it is seen that the specimen is illuminated by light falling vertically from above and to reach the eye this light must be reflected back into the objective. Any portion of the specimen that is not quite level will send the light to one side so that it will miss the objective, and that portion will appear dark to the observer. Now, unless the section which has been prepared is uniform in hardness, the soft places will be, to a certain extent, recessed, and the hard parts will stand out in relief, unless the utmost care has been used in preparation. The difference in level, however, is not abrupt, but the softer material slopes away from the hard. It is this slope which reflects the vertical beam of light to one side and appears dark.

VII. Some Illusions

Experiments show that the enamel polishes away faster than the metal. The enamel slopes away from the metal, steeply at first, but soon flattening out. The steep part of the slope appears as a dark line between enamel and metal. It is likely that some of the contentions for an interface layer are based on this illusory appearance.

Another type of illusion caused by the uneven surfaces is a phenomenon similar to the Becke line. The sloping surface just referred to is not a uniform slope but is dished on the enamel side. This dish may act as a concave semicylindrical mirror with a focus above it. This gives rise to a line of light which is best seen when the microscope is slightly out of focus and the objective is actually a little too far away from the specimen. With high magnification, there is a temptation to focus on this "Becke" line because it often presents a sharper focus than the surface of the enamel itself, and also because it appears at about the same level as the surface of the other material, *i.e.*, the metal.

VIII. How to Eliminate Illusions

The only way to eliminate these effects is to polish the specimen in such a manner that the hard and soft portions are at the same level. The paraffin wheel comes the closest to doing this, although it may be said that there is no perfect solution to the problem. A skilled microscopist can usually be reasonably sure, however, within the limits of possible resolution of the microscope, of the presence or absence of a separate phase, provided that he takes all conditions into account.

Figure 8 shows the effects of different methods of polishing and illumination in producing correct or incorrect appearances at the line of contact between enamel and metal.

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MECHANICS OF ENAMEL ADHERENCE, II

Effect of Composition and Firing Atmospheres on the Adherence of Ground-Coat Enamels[1]

By Walter C. Rueckel and R. M. King

ABSTRACT

The effect on adherence of the variation in the amount of cobalt oxide, nickel oxide, and manganese oxide, and the effect of atmosphere, air, oxygen, and nitrogen on adherence were studied. Enamels of same base but with varying amounts of the special oxides were made up, fired in the various atmospheres, and tested for adherence by drop-hammer impact methods and by flexure methods. A number of photographs of metallographic sections showing contact line between enamel and metal are given. General conclusions are (1) that adherence is not a function of the roughness of contact line, (2) that the adherence promoting effect of cobalt oxide is higher at 1.25% than at 2.5% or 5.0%, and (3) that the effect of oxygen and nitrogen in general is to decrease the adherence as measured by impact strength.

I. Introduction

The primary function of cobalt, nickel, and manganese oxides in sheet-steel ground-coat enamels has been considered to be the adherence of the enamel to the metal. All commercial ground coats contain some or all of these oxides and enamels not containing them can be chipped from the steel leaving a bright silvery steel surface. These facts have been accepted as evidence that these oxides are the cause of enamel adherence.

II. Review of Literature

The cobalt-silicate theory advanced by Vondracek[2] and Havas and Mayer[3] is that the cobalt oxide in the enamel forms a cobalt-silicate of lower oxygen content, which attacks the clean surface of the iron and joins more intimately with the metal and enamel ground coat.

In Tostman's cobalt-steel alloy theory,[4] cobalt oxide is reduced to the metallic state and alloys with the steel. Grünwald[5] visioned adherence as due to the increase in coefficient of expansion of an enamel by the addition of metallic oxides. This, however, has been disproved.

Berndt[6] stated that the cobalt oxide fixes the oxygen liberated by the iron oxide, which is formed between the enamel and steel and hence produces an enamel with greater adherence due to less of a bubble structure.

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[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Enamel Division). Received March 10, 1931.

[2] R. Vondracek, "Function of Ground Enamel," *Sprechsaal*, **44**, 115 (1911).

[3] M. Mayer and B. Havas, "Function of Ground Enamel," *ibid.*, **43**, 737 (1910).

[4] C. Tostman, "Function of Ground Enamels," *Keram. Rund.*, **19**, 5 (1911).

[5] J. Grünwald, Enameling of Iron and Steel. Text book.

[6] M. Berndt, "Rôle of Cobalt in a Ground Coat for Sheet-Steel Enamels," *Keram. Rund.*, **22**, 262 (1924).

This theory is also supported by Vielhaber,[7] who adds a saturation theory according to which cobalt oxide saturates and prevents solution of the iron oxide layer to which the enamel adheres.

Cooke[8] pictured the essential requirement for good adherence as being an interfacial layer between the ground coat and steel in which there was a

TABLE I

BATCH AND OXIDE COMPOSITIONS

(*a*) Commercial Glass

	Raw batch	SiO_2	Al_2O_3	K_2O	Na_2O	B_2O_3	Cryolite	CaF_2
Borax	−38.25				6.19	14.15		
Feldspar	−34.28	22.21	6.29	5.79				
Flint	−26.51	26.51						
$NaNO_3$	− 6.18				2.24			
Soda ash	−12.22				7.15			
Cryolite	− 2.54						2.54	
Fluorspar	− 7.52							7.62
	127.60	48.72	6.29	5.79	15.58	14.15	2.54	7.62

Total of melted oxides, 100.72.

(*b*) Simple Glass

	Raw batch	SiO_2	Na_2O	B_2O_3
Borax	95.1		15.4	35.2
Flint	40.6	40.6		
Soda ash	15.0		8.8	
	150.7	40.6	24.2	35.2

Total of melted oxides, 100.00.

decided decrease in richness of enamel toward the steel and a decrease in richness of steel toward the enamel.

Clawson[9] deduced that adherence was due to the ability of the cobalt oxide-bearing enamel to penetrate to process of the steel, thus gripping the steel firmly on cooling.

III. Plan of Investigation

Two types of enamels were selected for study: (1) An enamel which was known to be performing satisfactorily in commercial service and (2) a simple soda-boric oxide-silica glass. The purpose of the simple glass was to obtain some idea of the adherence rôle of ground-coat enamel in-

[7] L. Vielhaber, "Behavior of Metal Oxides in Ground Coats on Sheet Steel," *Ceram. Ind.*, **4**, 371 (1925); *Keram. Rund.*, **33**, 53–55 (1925).

[8] (*a*) R. D. Cooke, "The Effect of Furnace Atmosphere on the Firing of Enamel," *Jour. Amer. Ceram. Soc.*, **7** [4], 277 (1924).

(*b*) R. D. Cooke, "Making and Firing of Sheet-Steel Ground Coats," *ibid.*, **10** [6], 454–56 (1927).

[9] C. D. Clawson, "A Study of Adherence of Ground Coats to Sheet Steel," *Ceram. Ind.*, **13**, 164 (1929).

gredients. The formulas of these enamels are given in Table I. Cobalt, nickel, and manganese oxide additions were made as indicated in Table I.

These two type glasses with their variations in composition were then

TABLE II

VARIATIONS OF SPECIAL OXIDES

Composition of Melted Frit in Commercial Glass			Composition of Melted Frit in Simple Glass		
Batch No.	Commercial glass (%)	(%)	Batch No.	Simple glass (%)	(%)
O	100.00	0.00 metallic oxide	*o*	100.00	0 metallic oxide
A	98.75	1.25 cobalt oxide	*a*	98.00	1.25 cobalt oxide
B	97.50	2.50 " "	*b*	97.50	2.50 " "
C	95.00	5.00 " "	*c*	95.00	5.00 " "
D	98.75	1.25 nickel oxide	*d*	98.75	1.25 nickel oxide
E	97.50	2.50 " "	*e*	97.50	2.50 " "
F	95.00	5.00 " "	*f*	95.00	5.00 " "
G	97.50	2.50 manganese oxide	*g*	97.50	2.50 manganese oxide
H	95.00	5.00 " "	*h*	95.00	5.00 " "

fired in normal oxygen and nitrogen atmospheres and examined microscopically as well as tested for impact and flexure value.

The enamels were smelted as uniformly as possible to give frits containing minute and very uniform bubble structures. All of these frits were then milled for three or four hours with a uniform charge of pebbles. A fineness test of from three to five grams of residue from 100 cc. of enamel

TABLE III

IMPACT STRENGTH RESISTANCE TESTS

	Commercial glass compositions (atmospheres)				Simple glass compositions (atmospheres)			
No.	Normal (ergs)	Oxygen (ergs)	Nitrogen (ergs)	No.	Normal (ergs)	Oxygen (ergs)	Nitrogen (ergs)
O	3 × 490,500	1 × 490,500	3 × 490,500	*o*	3 × 490,500	3 × 490,500	3 × 490,500
A	15 × "	6 × "	10 × "	*a*	3 × "	15 × "	10 × "
B	6 × "	10 × "	6 × "	*b*	6 × "	15 × "	21 × "
C	6 × "	10 × "	6 × "	*c*	15 × "	10 × "	15 × "
D	10 × "	6 × "	6 × "	*d*	6 × "	15 × "	6 × "
E	15 × "	6 × "	6 × "	*e*	10 × "	10 × "	6 × "
F	21 × "	6 × "	15 × "	*f*	10 × "	10 × "	10 × "
G	3 × "	3 × "	6 × "	*g*	3 × "	3 × "	1 × "
H	6 × "	3 × "	6 × "	*h*	6 × "	3 × "	1 × "

on a 20-mesh screen was obtained, which was the criterion for drawing the mill. The mill addition used for the simple enamel was 7% Vallendar clay, while the mill addition for the commercial glass was 7% Vallendar clay, 0.5% $MgCO_3$, and 0.25% borax.

IV. Enameling Tests

The thickness of enamel applied to the steel was controlled as closely as could possibly be done with a spray gun.

The firings in normal atmosphere were made in a Westinghouse electric laboratory furnace. The oxygen and nitrogen firings were made in a specially constructed furnace.

(1) Impact Tests Impact tests were made on specimens fired in all three atmospheres. The test was made by a 500-gram weight falling through a height increasing in each succeeding blow by a 1-cm. increment, *e.g.*, 1 cm., 2 cm., 3 cm., etc. The work required to cause a separation of the enamel from the steel is expressed in Table III in ergs for all of the compositions.

(2) Conclusions Regarding Impact Resistance Adherence is not increased by cobalt or nickel oxide beyond a certain maximum content. Manganese oxide, alone, added to the enamels only slightly increased adherence.

In most cases the resistance to impact either becomes constant or decreases with an increase in percentage of oxide. The limit of saturation varies with the oxide used and with the composition of the enamel.

As in the impact tests manganese dioxide adds nothing to the adherence of the enamel.

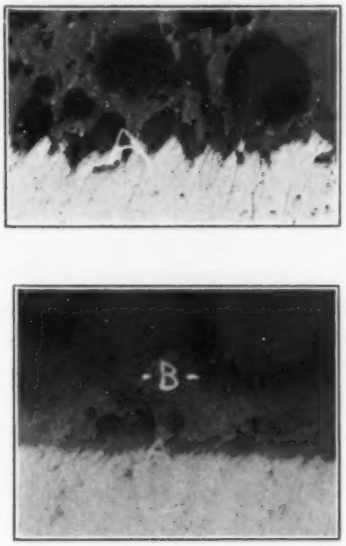

FIG. 1.—Top: commercial glass, no oxide, normal atmosphere. Bottom: commercial glass, 2.50% cobalt oxide, normal atmosphere.

In the commercial glass, cobalt oxide brings about a gradual increase in the flexure strength, while nickel oxide increases adherence to a maximum point and then causes a decrease in value until it actually lowers the flexure strength below that of the commercial glass with no metallic oxides. This result checks with Seabright.[10]

TABLE IV

FLEXURE TEST VALUES (HUNDREDTHS OF AN INCH)

Commercial glass series		Simple glass series	
Batch	Flexure value	Batch	Flexure value
O	27	*o*	28
A	28	*a*	36
B	28.5	*b*	42
C	43	*c*	56
D	30.5	*d*	39
E	30	*e*	53
F	25	*f*	60
G	28	*g*	30
H	28	*h*	35

[10] E. C. Seabright, "A Micrographic Study of the Adherence of Ground-Coat Enamels to Sheet Steel with Cobalt, Nickel, and Manganese Oxides Added as Mill Additions," Thesis, Ohio State Univ. (1930).

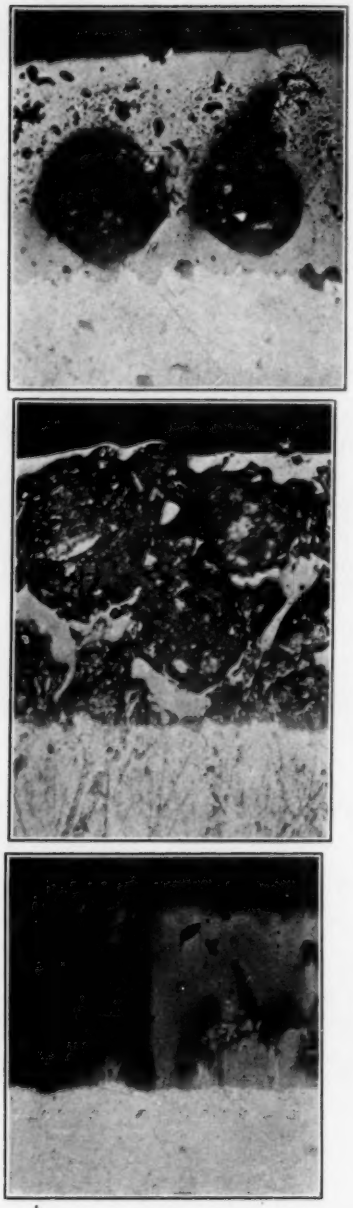

FIG. 2.—Top: simple glass, 1.25% cobalt oxide, normal atmosphere. Middle: simple glass, 2.50% cobalt oxide, normal atmosphere. Bottom: simple glass, 5% cobalt oxide, normal atmosphere.

Even 5% manganese oxide added to the glass gave a fair flexure value, while nickel oxide and cobalt oxide increased the flexure strength tremendously.

V. Microphotographic Examinations

Microphotographs of all trials were prepared by sawing a representative cross-section of the enamel from a specimen and grinding and polishing the enamel steel interface so that it would reflect light vertically from a metallographic microscope.

Except in a normal atmosphere the simple glass responds to increased impact strength by the addition of special oxides more than does the commercial type glass.

Cobalt oxide is not as effective as nickel oxide in the commercial glass fired in the various atmospheres except when used in small amounts, while the reverse is true in the simple glass. The end-point for tests on simple glass was taken as the point at which the bond between the enamel and steel was broken rather than a failure in the crushing strength of the enamel.

(1) Flexure Tests Flexure tests were made only on samples of enamels fired in normal atmosphere. The Lindemann-Danielson cross-bending machine was used. Table IV gives these results. The interface was photographed at a magnification of about 100 diameters.[11]

Figure 1 and the impact data in Table

[11] Conclusions to be drawn from the microphotographs (Figs. 1 to 4) must of necessity be quite general because if one so desires, a particular portion on each specimen could be located which might support any of the theories propounded and yet not be representative of the entire specimen.

III show that the theory of adherence as being due to a gripping of the steel by the enamel on a very uneven contact surface is erroneous. The letter *A* marks the contact line of the steel and ground-coat enamel. The upper photograph is of the commercial glass containing 2.5% cobalt oxide. The increased regularity of the contact line with addition of cobalt oxide is quite apparent. The same general tendencies were exhibited by all of the fifty-four samples examined.

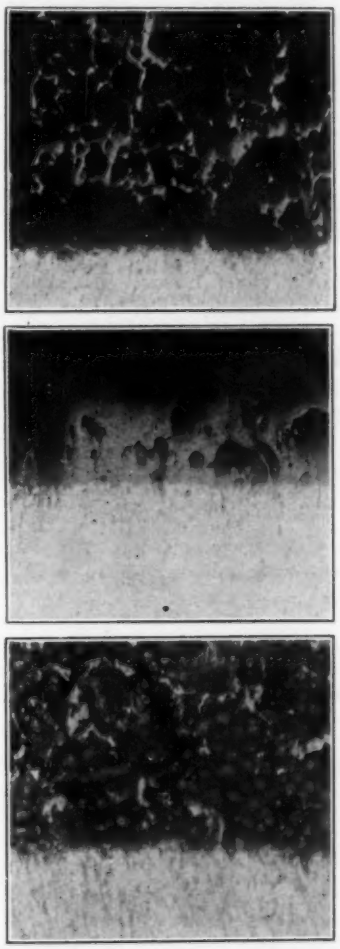

FIG. 3.—Top: commercial glass, no oxide, nitrogen atmosphere. Middle: commercial glass, 1.25% cobalt oxide, nitrogen atmosphere. Bottom: simple glass, no oxide, nitrogen atmosphere.

The microphotographs shown by Fig. 2 indicate that increasing cobalt oxide in the simple glass decreased the irregularities in the contact line *A* between enamel and steel. As the percentage of cobalt oxide increased there was a marked increase of both flexure and impact strength.

In Fig. 3, microphotographs show the peculiar structure obtained by firing in nitrogen atmosphere. Nitrogen in almost every case produced a more vesicular structure than did oxygen or normal atmospheres. Each type of glass without special oxides shows this to a marked degree (Oo), while with special oxide addition it is noticeable to a much less extent.

Figure 4 is a typical microphotograph of the enamels fired in oxygen atmosphere.

FIG. 4.—Commercial glass, 1.25% cobalt oxide, oxygen atmosphere.

VI. Conclusions

(1) Manganese oxide alone adds very little to the impact or flexure strength of a ground-coat enamel.

(2) The results indicated by microphotographs and impact tests tend to disprove the theory of adherence based on penetration of the steel by enamel and on the presence of a rough surface which the enamel is able to grip.

(3) Values from impact tests reach a maximum in commercial enamels with 1.25% cobalt-oxide content and decrease with 2.5 and 5.0% cobalt oxide; values for nickel oxide increase as the percentage of nickel oxide increases; values for manganese oxide increase slightly with increase in percentage.

(4) Except in the case of enamels containing 2.5 and 5.0% cobalt oxide, the effect of oxygen and nitrogen atmosphere is to decrease the impact resistance of commercial enamels.

(5) With the exception of compositions containing 1.25% special oxide, nickel oxide is more effective in increasing impact resistance than cobalt oxide in commercial enamels fired at normal atmospheres.

(6) Values for impact strengths in simple glass indicate that the same relation does not hold for nickel and cobalt oxides. The effect of cobalt oxide is to increase impact resistance up to and including 5% quantities. Maximum effect of nickel oxide is reached with 2.5% quantities.

(7) The effect of change of firing atmosphere for the simple glass is to raise the impact resistance in both oxygen and nitrogen, the higher values being obtained in oxygen.

(8) In general, the effect of special oxides in flexure values is insignificant in the commercial enamels but very marked in the simple glass as the concentration of the oxide is increased.

Acknowledgment The authors are indebted to J. O. Lord of the Department of Metallurgy for assistance in making the polished specimen and photomicrographs.

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MECHANICS OF ENAMEL ADHERENCE, III

Enamels on Copper: the Nature of Their Adherence[1]

BY W. K. CARTER AND R. M. KING

ABSTRACT

A study of the use of sheet-steel enamels on copper showed that cobalt oxide decreased the adherence of the enamel. Several sheet-steel enamels were fired on copper and in general the adherence was less than on sheet steel. A white cover coat was found to be most satisfactory for copper. Several color photographs are given showing contact lines between enamel and copper, enamel and gold, and enamel and silver.

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[1] Presented at the Annual Meeting, AMERICAN CERAMIC SOCIETY, Cleveland, Ohio, February, 1931 (Enamel Division). Received March 14, 1931.

I. Introduction

A number of sheet-steel ground-coat enamels of a basic composition which has been taken as standard, were applied to sheet steel, and the effects of varying amounts of the oxides of nickel, cobalt, and manganese were studied.

The results obtained when these same standard enamels as well as several other types of enamels were applied to copper are reported here. Some results with enameled gold and silver are also given.

II. Enameling Process

There are many methods of enameling copper. The process used here is practical within laboratory limitations.

The copper plates were first subjected to a temperature of 1000 to 1100°F (normal atmosphere) in an electric furnace until covered with a black copper oxide scale; they were removed and allowed to cool slightly and placed in a pickling bath of 1 part H_2SO_4 and 7 parts H_2O (volume), heated to a temperature of 150 to 160°C. Twenty minutes should be sufficient to dissolve the scale and give the plate a dull red color. The plates should be immersed in boiling water for a few minutes, and scrubbed under running water with a bronze wire brush until a bright surface is obtained and the water spreads readily and wets the entire surface. The plate was then dried between clean linen clothes and applied to the enamel at once.[2]

The wet process was used to apply the sheet-steel ground-coat enamels to copper. The other enamels were applied dry by dusting, the enamels being ground to such grain size that they passed an 80-mesh screen and remained on a 100-mesh screen. The enamels were all fired in an electric furnace in a normal atmosphere.

III. Procedure of Testing and Examination

(1) **Impact Test** The equipment employed consisted of a steel plunger supported so as to be free to move vertically. One end of this rod is shaped to a ball point and this rests on the enameled surface of the piece to be tested. On the other end of the plunger is dropped a 500-gram weight, first from a height of 1 cm. and then from 2 cm., etc., increasing the height of fall by 1 cm. for each impact. The work which causes the enamel to spring from the metal is calculated in ergs.

(2) **Flexure Test** One end of the piece is held rigid and the other end is bent through an angle of 45°.

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[2] It is essential that the enamel be applied as soon as possible as oxide formation is very rapid if plates are exposed to the atmosphere. Care must also be taken not to touch the surface of the plates after drying.

(3) Microscopic Examination Microscopic examination of polished cross-sections reveals the contact line between enamel and metal.

IV. Enamels Applied and Results Obtained

(1) Commercial Enamels on Copper The commercial enamel glass used in this investigation has the following composition:

Borax	38.25	Na_2CO_3	12.22
Feldspar	34.28	Cryolite	2.54
Flint	26.51	Fluorspar	7.62
$NaNO_3$	6.18		

To this glass, which is a successful commercial enamel, special oxide additions were made in the frit. To afford consistent comparison with the results obtained with sheet steel, all enamels in the following series were applied by the wet process.

Enamel	Impact test results	Adherence-bending test observation
Commercial glass containing no oxide	$10 \times K$*	No adherence
" " " 1.25% CoO	$10 \times K$	" "
" " " 2.5% "	$10 \times K$	" "
" " " 5.0% "	$3 \times K$	" "
" " " 1.25% NiO	$6 \times K$	" "
" " " 2.5% "	$10 \times K$	" "
" " " 5.0% "	$10 \times K$	" "
" " " 2.5% MnO	$6 \times K$	" "
" " " 5.0% "	$6 \times K$	" "
" " " 2.5% MnO†	$6 \times K$	" "
" " " 5.0% MnO†	$6 \times K$	" "
" " " 2.5% FeO ‡	$6 \times K$	" "

† From $KMnO_4$.
‡ From FeO_4.

* K = 490,500 ergs.

The following series were applied by the dry process:

Commercial glass containing no oxide	$6 \times K$	Good adherence
" " " 2.5% CoO	$10 \times K$	No "
" " " 5.0% NiO	$10 \times K$	Good "

Commercial high-lead enamels

Blue (opaque)	$10 \times K$	No adherence
Yellow (transparent)	$3 \times K$	No "
Black (opaque)	$21 \times K$	Fine "

Standard white cover coat for sheet steel

Silica	17	Cryolite	11
Feldspar	35	Salt peter	4
Soda ash	6	Borax	23
Fluorspar	4	(No mill addition)	

Standard white	76–92 mesh	$15+ \times K$	Best adherence
" "	Finer than 200-mesh	$10 \times K$	Poor "
" "	Between 100 × 200-mesh	$15 \times K$	Fair "
" "	" 100 × 80- "	$15+ \times K$	Best "
" "	" 80 × 60- "	$15 \times K$	Good "
" "	" 20 × 60- "	$15 \times K$	Good "

Standard white	Containing 1% CoO			
	Finer than 200-mesh	10	$\times K$	No adherence
	Between 20 × 60-mesh	15	$\times K$	Fair "
Standard white applied by wet process with mill addition		10	$\times K^*$	Good adherence

* K = 490,500 ergs.

(2) Gold and Silver Enamels The gold enameled specimens gave adherence values as follows:

$$10\ \text{K} - 3 \times K^*$$
$$24\ \text{K} - 6 \times K$$

The specimens were too small to subject to flexure tests.

The silver specimen was too small to subject to either impact or flexure tests.

V. Discussion of Results

(1) Adherence Tests, Impact vs. Bending It is felt that an analysis of the results reported as impact values should perhaps be supplemented with a few observations as to the behavior of some of the enamels when subjected to bending tests. For example, the standard enamel containing cobalt oxide in amounts of 1.25% and 2.5% gave practically the same impact values as the blue commercial high lead enamel, yet when the enameled plate is flexed, the standard enamels splinter off in small narrow slivers, while the high lead oxide enamels break off in large sections. Once the standard enamel is fractured, it will often fly off without further straining of the plate, indicating, probably, a more strained condition of the enamel, due to a difference in thermal expansion. It should be noted also that the high lead oxide enamels are more dense in structure than the standard enamels. All of the enamels broke away from the plate, leaving a clean metal surface (to the unaided eye), with the following exceptions: (*a*) standard white steel cover coat, (*b*) standard commercial glass applied dry, (*c*) commercial black, high lead oxide enamel, and (*d*) standard commercial glass with 2.5% nickel oxide added in the frit, applied dry.

(2) Microscopic Examination All the enamels applied to copper reveal a straight contact line. All specimens, however, show a distinct change in the metal phase at the contact line. Only in the case of the standard white cover-coat enamel is this change visible to the unaided eye. Enameled silver and gold specimens also reveal straight contact lines. In the 10 K gold specimen (14 parts copper to 10 parts gold), a distinct change is noted at the contact line. Accompanying microphotographs in color of the following sections were prepared:

(1) Standard white cover coat on copper (etched).
(2) White commercial enamel on 24 K gold (etched).
(3) White commercial enamel on 10 K gold (etched).
(4) Green commercial enamel on silver (polished).

VI. Discussion of Microphotographs

(1) Standard White Cover Coat

(*a*) In the metal phase (Fig. 1) is a dark discoloration or change in structure appearing in the vicinity of the line of contact between the metal and the enamel. This is not so evident in the polished section as the etched section. Thus one is led to believe with little doubt that this discolored band is the eutectic mixture of copper and cuprous oxide familiar to metallurgists. This formation is due to the solution into the copper phase of oxide at a high temperature and the precipitation of the cuprous oxide in place as very small, discrete particles upon cooling.

(*b*) In the enamel phase a red coloration is first noted, apparently diffused from the line of contact into the enamel. This would indicate that the enamel was in process of dissolving some constituent off the surface of the metal at the time of firing. This constituent might well have been some excess copper oxide which coated the surface of the metal. Another phase, light blue in color, appears scattered through the enamel as small particles and thin lines, near but not touching the line of contact. This is probably some compound that was precipitated upon cooling the enamel material which contained certain amounts of the copper oxide. This effect of precipitation upon cooling seems all the more plausible because of the fact that in many locations the structure seems to be that of a eutectic.

(2) White Commercial Enamel on 24 K Gold

There appears to be no change of structure in Fig. 2 in either the metal or enamel phase.

(3) White Commercial Enamel on 10 K Gold

(*a*) In the enamel phase in Fig. 3 there appears a slightly darker discoloration in the vicinity of the line of contact. This is not a change in structure, being due to the reflection of the polished metal surface and can be varied by changing the illumination.

(*b*) In the metal phase a change of structure is evident in the vicinity of the line of contact between the metal and the enamel. This is shown in the polished section as a layer through which a great number of darker colored specks are dispersed, these darker colored areas being greatest in number as they approach the contact line between the enamel and the metal. The etched section reveals this layer as being of distinctly different structure. An etching solution of chromic acid and HCl attacked the metal except in this area next to the contact line, revealing an alloy structure. The unetched area is revealed as a very regular fairly thick line along the contact line. This line appears to include within its boundaries all the discolored specks observed in the polished section. It is evident

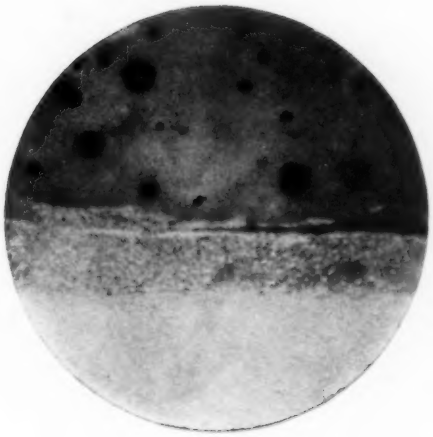

FIG. 1.

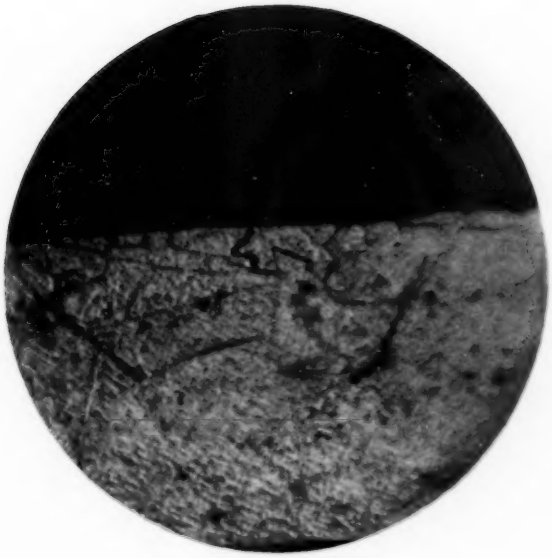

FIG. 2.

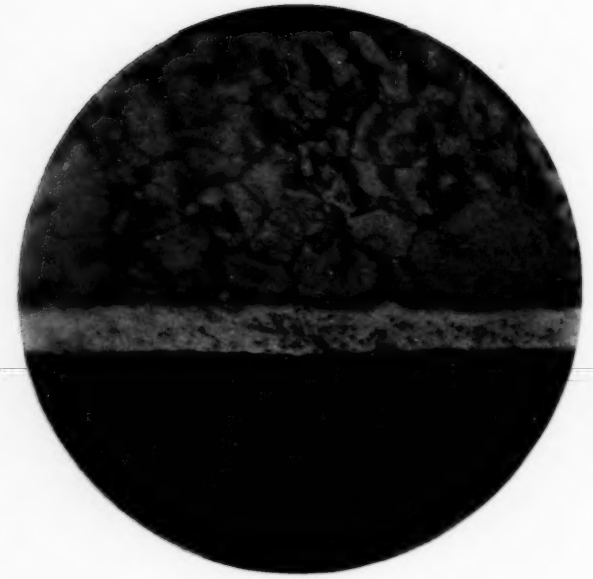

FIG. 3.

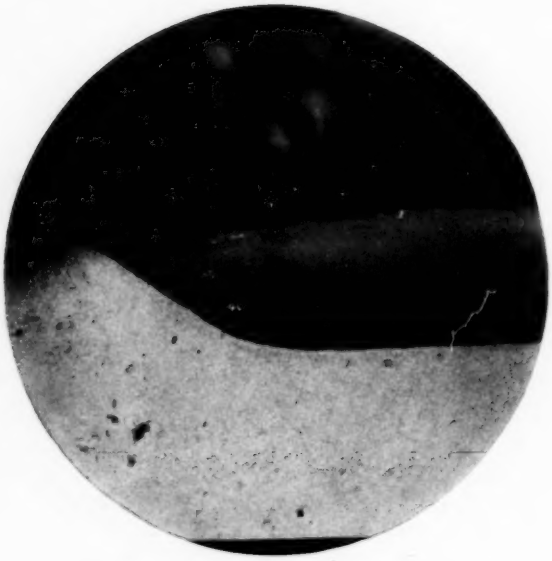

FIG. 4.

that the structure of the alloy in this area has been altered by the heat treatment attendant to enamel fusion, leaving a layer of gold at the contact line through which the copper is dispersed in the form of finely divided particles of copper oxide.

(4) Green Commercial Enamel on Silver There appears no change of structure in either the metal or enamel phase.

VII. Effect of Grain Size

It was thought that perhaps the grain size of the enamel was a determining factor in the formation of the material evident at the contact line. To determine the effect of grain size, the standard white cover-coat enamel was ground to varying grain sizes, ranging from finer than 200-mesh to coarser than 60-mesh and finer than 20-mesh. It was believed that the larger grain sizes would not flux over as quickly as the smaller and would thus allow a greater degree of oxidation of the plate before the top surface could flux over. The firing time was also varied. The thickness of the intermediate layer of copper and Cu-CuO eutectic was found to vary directly with the grain size, and the degree of solution of this compound into the enamel varied directly with the firing time. In some specimens the pink color had diffused entirely through the enamel and the intermediate phase was no longer visible to the unaided eye. In this case adherence was very poor, as evidenced by the flexure test.

A study of the microphotographs together with observations in the grain size study leads to the conclusion that maximum adherence is obtained on copper under the following conditions:

(1) When the enamel applied is capable of taking into solution the oxide layer formed on the surface of the metal during firing, thus obtaining a direct enamel to metal contact rather than the metal to oxide to enamel form of bond.

(2) The enamel must be capable of taking into solution a sufficient amount of the oxide so that a metal-enamel contact is obtained on at least part of the interface before the saturation point of the enamel as relating to the oxide is reached. If the enamel becomes incapable of taking more oxide into solution while there still exists only an enamel-oxide interface there is poor adherence.

VIII. Conclusions

(1) Standard sheet steel ground coats on copper.[3]

(*a*) Enamels containing cobalt oxide adhere to steel slightly better than they do to copper, when judged by impact tests. According to the bending tests, however, adherence to copper is markedly poorer than it is to steel.

(*b*) Enamels containing nickel oxide adhere to steel better than to

[3] All comparisons with steel were made with Rueckel's results. See "A Study of Ground Coat Adherence, II," by W. C. Rueckel and R. M. King, this issue *Jour. Amer. Ceram. Soc.*, p. 782.

copper according to impact tests, but they adhere to copper better than enamels containing cobalt oxide according to both impact and bending tests.

(*c*) Enamels containing manganese oxide have only slight adherence to both copper and steel.

(*d*) The best adherence was obtained with the black commercial high-lead enamel and the standard white cover coat, as evidenced by the bending tests.

(*e*) The addition of cobalt oxide diminishes the adhering power of the standard white cover coat.

(*f*) There is marked difference in the results obtained with wet and dry application.

Some results obtained upon application of sheet steel and other enamels to copper.

The following table affords a comparison of impact values obtained with steel and copper. (Applied by wet process—fired in normal atmosphere.)

Enamel (commercial glass with the following oxide variations)	Impact values	
	Copper	Steel
No oxide addition	$10 \times K$	$3 \times K$
1.25% CoO	$10 \times K$	$15 \times K$
2.5 "	$10 \times K$	$6 \times K$
1.25 NiO	$6 \times K$	$10 \times K$
5.0 CoO	$3 \times K$	$6 \times K$
2.5 NiO	$10 \times K$	$15 \times K$
5.0 NiO	$10 \times K$	$21 \times K$
2.5 MnO	$6 \times K$	$3 \times K$
5.0 MnO	$6 \times K$	$6 \times K$
2.5 CuO	$10 \times K$	
2.5 FeO	$6 \times K$	

Upon flexure all of the above enamels on copper broke from the plate leaving (to the unaided eye) an apparently clean unaltered surface.

The addition of 1% CoO to the standard white cover coat materially decreased adherence.

Acknowledgment The authors are indebted to J. O. Lord of the Department of Metallurgy for making the color plates.

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CERAMIC ABSTRACTS[1]

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Vol. 10 October, 1931 No. 10

Abrasives

Abrasive finishing essential in chromium practice. Anon. *Abrasive Ind.*, **12** [8], 41–44 (1931).—Only one material commercially available at the present time for plated surfaces combines hardness greater than case-hardened steel, brilliant luster, and resistance to atmospheric and other corrosive agents. This material is chromium as electrodeposited. Chromium is far more available than nickel. Large deposits are found in Rhodesia, New Caledonia, and British South Africa. It has been used for many years, principally in making pigments and in making special steel. The Chromium Corp. of America holds U.S. patents covering its chromium-plating processes and acts as a licensing organization to other chromium-plating plants in addition to operating four plants of its own. The grinding, polishing, and buffing problems necessary to insure proper chromium plating are discussed. E.P.R.

Adhesion of glue to fused-alumina abrasives. Henry R. Power. *Metal Cleaning & Finishing*, **3** [7], 597–98 (1931).—It was formerly common practice to measure the adhesion value of the abrasive to glue by the so-called capillarity test or height of rise of water in an open tube filled with abrasive, but it has been found that in order to obtain true values this test must be supplemented by the briquet test in which a briquet of dried glue and abrasive is pulled apart. This is necessary as it has been found that abrasives may have the same capillarity values with different surface-tenacity results. See also *Ceram. Abs.*, **10** [7], 469 (1931). E.J.V.

Planetary grinding. Anon. *Abrasive Ind.*, **12** [8], 24–26 (1931).—In planetary grinding the grinding wheel has a planetary motion, rotating on its axis. At the same time its axis travels in a circle. This tool was developed for a more efficient and accurate means of finishing cylinder blocks. E.P.R.

Close precision grinding for piston rings. Perfect Circle Co. *Abrasive Ind.*, **12** [8], 16–19 (1931).—This company depends upon grinding, in large measure to produce accurate piston rings in large quantities. The machines and operations used are described in detail. E.P.R.

Eliminating noise by gear grinding. Anon. *Abrasive Ind.*, **12** [8], 23 (1931).—Motors have been perfected until they are quiet running, but there remained the noise created by transmission and rear axle gearing. This problem has been solved through the employment of grinding for finishing the tooth surfaces after they are heat treated. Gear grinding for Cadillac transmission is described. This machine works on the generating principle, *i.e.*, the gear moves with a rolling motion as the wheel is in contact

[1] The abbreviation (*C.A.*) at the end of an abstract indicates that it was obtained from *Chemical Abstracts* by coöperative agreement.
The bold-face number following the journal name is the volume, the issue number is in brackets followed by the page numbers, then the year in parentheses.

with the tooth flank, thus generating the correct curve. This is called the generating principle because the tooth curves are actually generated as distinguished from teeth that are ground by means of formed wheels. Illustrated. See also *Ceram Abs.*, **10** [8], 533 (1931). E.P.R.

Efficient metal removal essential to offhand grinding. ANON. *Abrasive Ind.*, **12** [8], 29–30 (1931).—The lack of precision work-holding and feeding mechanisms places the burden of successful result directly on the manual skill of the operator. Methods of mounting new wheels are described in detail and types of work rests and their uses are discussed. Recent methods in snagging with floor and swing-frame grinders are also described. E.P.R.

Modern competition in grinding. E. W. JOHNSON. *Abrasive Ind.*, **12** [8], 21–23 (1931).—J. points out that keen competition can be met successfully by employing grinding wherever practicable in the manufacture of bulky parts. E.P.R.

Regrinding problems solved by expert workmanship. FRED B. JACOBS. *Abrasive Ind.*, **12** [8], 20–21 (1931). E.P.R.

Tool grinder base of welded steel. FORBES & MYERS. *Abrasive Ind.*, **12** [8], 39 (1931).—A tool grinder recently developed is electrically driven and the pedestal is of welded steel construction. The motor operates at 1800 r.p.m. The grinding wheels are 10 in. in diameter with 1-in. face. E.P.R.

Air-driven grinder. INGERSOLL-RAND CO. *Abrasive Ind.*, **12** [8], 39 (1931).—A new grinder and sander of the multiple-vane type has been developed. It is a light-weight, high-production machine which is suitable for grinding, sanding, polishing, and wire-brushing operations. It is said to be a powerful, smooth-running, correctly balanced tool. E.P.R.

Improved grinder. HISEY-WOLF MACHINE CO. *Abrasive Ind.*, **12** [8], 39–40 (1931).—A bench grinder recently improved to comply with the more stringent electric codes is designed to accommodate wheels 6 and 7 in. in diameter and is equipped with an improved communicating-type repulsion induction motor. Illustrated. E.P.R.

Polishing data. ANON. *Abrasive Ind.*, **12** [8], 35–36 (1931).—The following questions are answered and discussed: (1) In polishing spots on heat-treated stock for testing hardness, what is the correct peripheral speed to employ? (2) Will heating glue to a high temperature spoil it and should only a sufficient amount be prepared to last for one day to avoid reheating? (3) After it is set up, how long should a wheel be allowed to dry before using? (4) Should all the old abrasive be removed entirely each time before applying new glue and abrasive and what is the best method of removing? (5) Should the fir between the hole in the wheel and the spindle diameter be very close to avoid runout and prolong the life of the wheel? (6) Should a wheel be used until practically all the abrasive has been worn off? (7) What is the difference between setting up a wheel and reheating it? E.P.R.

Studies in metal polishing. IV. EDWIN M. BAKER AND GEORGE E. HOLBROOK. *Metal Cleaning & Finishing*, **3** [7], 555–60 (1931).—Sizing of polishing grain and the adoption of standards for abrasive grains are discussed. The "G.M.C." abrasive grains are commented upon. A brief outline of the work now in progress on standards for testing sieves is presented. Illustrated. For Part III see *Ceram. Abs.*, **10** [9], 616 (1931). E.J.V.

New features of cut-off machine. ANDREW C. CAMPBELL, INC. *Abrasive Ind.*, **12** [8], 39 (1931).—An abrasive cut-off machine is designed for the rapid and accurate cutting of steel, iron, nonferrous materials, fiber, etc., in both production and non-production work. The grinder operates on a principle wherein the abrasive disk is moved through the material by a travel arm arranged so that the spindle travels parallel to the top of the table without the use of slides. Illustrated. E.P.R.

Formed wheels trued accurately. CHURCHILL MACHINE TOOL CO., LTD. *Abrasive Ind.*, **12** [8], 40 (1931).—In the set-up, a previously ground piece of work is used as a master bar to actuate the wheel-forming device for grinding subsequent parts on a plane grinding machine. Illustrated. E.P.R.

Mass production of light parts. ANON. *Abrasive Ind.*, **12** [8], 37–38 (1931).—The new Landis hydraulic grinder is a comparatively small, rapid-traverse, plane grinding machine, highly flexible but at the same time ideal for the mass production of light parts. E.P.R.

Grain standards. ANON. *Abrasive Ind.*, **12** [8], 36 (1931).—Grain-sizing standards and testing sieves were the principal subjects of discussion at the quarterly meeting of the Technical Committee of Producers of Electric Furnace Abrasives held June, 1931, at Niagara Falls, Ont. E.P.R.

BOOK

1931 Edition of the Schleif Industrie Kalendar. BERNHARD KLEINSCHMIDT. 6th ed. Verlag dês Schleifindustrie Kalendars, Düsseldorf, Germany. 364 pp. *Abrasive Ind.*, **12** [8], 36 (1931).—The book reviews grinding and polishing practice in Germany. Manufacture of abrasives and grinding wheels with the characteristics of various materials, polishing and grinding practices, and a review of abrasive machine equipment are included. It will be found valuable by American abrasive men possessing a reading knowledge of German. E.P.R.

PATENTS

Work-size mechanism for grinding machines. RAYMOND A. COLE. U. S. 1,815,049, July 21, 1931. In a grinding machine, a work support and grinding element relatively movable to effect a grinding feed, feeding mechanism, a calipering device, a fluid-pressure system operating under low pressure and including a valve governed by the calipering device, and a high-pressure system for operating the feeding mechanism controlled in its action by the valve of the low-pressure system.

Grinding wheel. THURE LARSSON AND HUGO W. H. BETH. U. S. 1,815,108, July 21, 1931. A grinding wheel comprising a rotatable support, a plurality of abrasive segments thereon, clamping means to secure the segments on the support, and deformable non-elastic means located between a face of a segment and another part of the wheel which coöperates with the clamping means to hold the segment rigidly in position but will yield under excessive pressure due to temperature expansion of the wheel.

Tool-grinding machine. KURT METZLER. U. S. 1,815,112, July 21, 1931. A machine for grinding tools comprising a work spindle, a work-spindle holder reciprocable in the longitudinal direction of the work spindle, means for rotating the work spindle according to the curvature of the edge of the tool to be ground, means for feeding the work spindle after each reciprocation of the work-spindle holder, a driving shaft, reversible transmission gear adapted to connect the work-spindle holder with the driving shaft for displacement in the longitudinal direction of the work spindle and for the spindle rotation, a clutch for actuating the reversible transmission gear, a second clutch for releasably connecting the work-spindle feeding means with the driving shaft, means for automatically releasing the first clutch when the work spindle reaches one end of its travel, means for automatically engaging the first clutch when the work spindle reaches the other end of its travel, and means for automatically engaging the second clutch when the first clutch is released and releasing the second clutch when the first clutch is engaged.

Feeding mechanism. EINER WILLIAM LARSEN. U. S. 1,815,262 and 1,815,263, July 21, 1931. (1) In a mechanism for feeding articles to a grinding machine, a travel-

ing belt for receiving and advancing an article, a member having a passage therein for guiding the article from the discharge end of the belt to the grinding machine, and means including a passage communicating with the guide passage for directing a fluid under pressure to the surface of the article to advance it through the passage. (2) In an article-feeding mechanism, a pair of magnetic rollers of opposite polarity, a hopper for successively delivering articles to the rollers, and means including a reciprocable bar for driving the rollers to advance an article delivered thereto.

Grinding gears. BERNARD E. SHLESINGER AND THOMAS M. DURKAN. U. S. 1,815,336, July 21, 1931. The method of grinding a longitudinally curved tooth gear which consists in rotating a grinding wheel on its axis while moving the wheel continuously in a closed path and imparting simultaneously to the gear a continuous rotary motion in such timed relation to the last-named movement of the wheel that the gear is continuously indexed.

Grinding machine. ROGER N. HEALD AND WALDO J. GUILD. U. S. 1,816,082, July 28, 1931. In a grinding machine, a cross-feed screw, means to turn the screw to produce the normal cutting feed of the machine, screw-threaded means surrounding the cross-feed screw, and means to turn the last-named means upon completion of a grinding operation, whereby to move the cross-feed screw axially to cause the grinding operation to cease.

Grinding machinery. CLEMENT BOOTH. U. S. 1,816,170, July 28, 1931. A grinding machine of the centerless type including a grinding wheel operable at a high-grinding rate of speed, an opposed regulating wheel operable at a slow work-controlling rate of speed, a column member projecting adjacent the throat between the wheels, means carried by the column for restraining axial movement of a work piece in the grinding throat, and an additional means carried by the column for radially shifting a work piece relative to the grinding throat.

Valve grinder. CLEMENT BOOTH. U. S. 1,816,171, July 28, 1931. A grinding machine, including a grinding wheel and a regulating wheel, means holding the work laterally against the regulating wheel, ejector-stop mechanism for holding the work axially toward the regulating wheel, a rock arm to successively engage, actuate, and disengage the ejector mechanism on movement in a work-ejecting direction, means for returning the ejector to work-stop position on such disengagement, and adjustable means for variably limiting the stop position of the ejector.

Crank-grinding machine. AMOS P. STEINER, PAUL STONER, AND CHARLES P. HARRISON. U. S. 1,816,750, July 28, 1931. A crank-grinding machine comprising a grinding wheel, a work carriage, fluid-operated crankshaft clamping means thereon, fluid-operated means for causing relative axial movement of the wheel and the work carriage to bring successive cranks in the same plane into operative relation to the wheel, and a manually operable lever for controlling the fluid-operated means, the same lever being biased to return to inoperative position when released by the operator.

Grinding machine. CLARENCE C. STEVENS. U. S. 1,817,953, Aug. 11, 1931. In a machine, in combination, a work holder, means for rotating the work holder, a tool for operating on a work piece on the holder, a size-testing member for engaging the work piece, fluid-pressure means for controlling the operation of the holder to grip the work piece, a valve for controlling the fluid-pressure means, a spring tending to operate the valve, a latch for the valve, and mechanism controlled by the size-testing member for releasing the latch for causing the fluid-pressure means to stop the work holder and release the work piece.

Method of grinding. ADOLPH L. NELSON. U. S. 1,818,084, Aug. 11, 1931. The method of finishing a hollow, cylindrical article which comprises supporting the interior of an open end in such a way as to support the wall of the article more firmly

along one diameter of the article than along a second diameter at right angles to the first diameter, and then grinding the exterior of the article.

Oval grinding. ADOLPH L. NELSON. U. S. 1,818,085, Aug. 11, 1931. The method of finishing a hollow, cylindrical article which comprises expanding an end of the article into oval exterior shape, grinding the exterior surface of the expanded cylinder into truly cylindrical shape, and then releasing the expanded end to permit the exterior circumference thereof to assume an oval shape.

Hydraulic honing and lapping machine. THOMAS F. QUIGLEY. U. S. 1,818,098, Aug. 11, 1931. In a honing or lapping tool, in combination, a head, a plurality of abrading members carried by the head, expanding elements coöperative with opposite ends of the abrading members, and means connecting these elements for separate movement to maintain the expanding elements in positions positively holding the abrading members to their work, the means allowing the expanding members to move relative to each other during the abrading operations.

Grinding machine. ERNEST A. WALKER. U. S. 1,818,288, Aug. 11, 1931. In a grinding machine, a grinding wheel, means to support the grinding wheel and work to rotate on substantially parallel axes, means to adjust the wheel toward and from the work, means to move the wheel axially over an extended range of adjustment relative to the work, and additional means to move the work and work-supporting means axially of the wheel over a limited range of operative movement relative to the wheel, and means to limit the range of operative movement.

Surface-grinding machines. C. E. JACKSON, T. J. HUNT, AND R. C. TURNER. Brit. 351,964, July 15, 1931; see also *Ceram. Abs.*, **10** [9], 614 (1931).

Centerless grinders. H. HORSLEY. Brit. 352,028, July 15, 1931.

Machines for polishing or grinding cam tracks, etc. J. G. DOUGLAS. Brit. 352,145, July 15, 1931.

Hand-grinding or sandpapering machine with an endless grinding band. F. QUINKERT. Brit. 352,754, July 22, 1931.

Molded articles, *e.g.*, grinding wheels. BAKELITE CORP. Brit. 353,019, July 29, 1931.

Abrasive tools. BRITISH THOMSON-HOUSTON CO., LTD. Brit. 353,663, Aug. 6, 1931.

Art and Archaeology

New lines in china and glass. ANON. *Pottery Glass & Brass Salesman*, **43** [15], 12 (1931).—Full descriptions are given of the special lines in pottery and glassware of the following companies: (1) Geo. Borgfeldt & Co., (2) Liberty Works, (3) Gift and Art Bureau, (4) Cataract-Sharpe Mfg. Co., (5) Central Glass Works, (6) Sloan Bros. *Ibid.*, **43** [16], 12 (1931).—(1) Copeland & Thompson, Inc., (2) Lo'Brie, Ltd., (3) Otto Goetz, Inc., (4) Corning Glass Works, (5) Fostoria Glass Co., (6) Edmondson Warrin, Inc. *Ibid.*, **43** [17], 11 (1931).—(1) Fulper Pottery, (2) Mogi, Momonoi & Co. *Ibid.*, **43** [19], 11 (1931).—(1) Justin Tharaud, Inc., (2) Bartlett-Collins Co., (3) Lazarus & Rosenfeld. *Ibid.*, **43** [20], 11 (1931).—(1) Heinrich & Winterling, Inc., (2) Skinner-Hill Co., (3) Crooksville China Co., (4) Salem China Co. *Ibid.*, **43** [21], 12 (1931).—(1) W. S. George Pottery Co., (2) Dunbar Glass Corp., (3) A. E. Hull Pottery Co., (4) Hocking Glass Co. *Ibid.*, **43** [22], 11 (1931).—(1) Maddock & Miller, Inc., (2) A. H. Heisey & Co., (3) Steubenville Pottery Co. *Ibid.*, **43** [23], 11 (1931).—(1) Cox & Co., (2) Koscherak Bros. *Ibid.*, **43** [24], 12 (1931).—(1) Rowland & Marsellus Co., (2) United States Glass Co., (3) Atlas-Globe China Co. *Ibid.*, **43** [25], 12 (1931).—(1) Neuwirth Importing Co., (2) John B. Salterini. *Ibid.*, **43** [26], 12 (1931).—Wm. S. Pitcairn Corp.

Crockery & Glass Jour., **109** [5], 22–23 (1931).—(1) Heinrich & Winterling, Inc., (2) United States Glass Co., (3) Horace C. Gray Co. *Ibid.*, **109** [7], 16, 24, 38 (1931).—(1) Maddock & Miller, Inc., (2) Fulper Pottery, (3) Fostoria Glass Co. *Christian Sci. Mon.*, **23** [196], 6 (1931).—Modern ideas in shapes and decorations are discussed. E.P.R.

Art-glass production. HOWARD B. BURTON. *Stained Glass; Nat. Glass Budget*, **47** [9], 19 (1931).—There is evidence that the best stained glass since the 13th Century is being produced today in American studios and workshops. E.P.R.

Glassware of R. Lalique. J. HOLROYD REESE. *Christian Sci. Mon.*, **23** [203], 8 (1931).—Lalique's production of glassware falls into two categories. The first is that in which he uses more or less traditional shapes applying unfamiliar ornaments to his objects. The second class comprises objects not usually seen in glass. His most remarkable pieces are vases, bowls, lampshades, and ornaments conceived and designed for the collector. E.J.V.

Glass and chinaware. SCHEFOLD. *Sprechsaal*, **64** [29], 536–39 (1931).—Several photographs of glasses, china, and tableware are given which were exhibited at Stuttgart, Germany. W.M.C.

English bubbly glass. ANON. *Crockery & Glass Jour.*, **109** [7], 24 (1931).—Interesting ancient models in tall vases, flower bowls and flower glasses, and numerous large body jars and vases with a variety of smaller bowls comprise some of the flower containers. The little bubbles running through this glass hold its historic interest. E.P.R.

Variety in Roman glass. EUROPEAN SPECIALTY CO. *Crockery & Glass Jour.*, **109** [6], 22 (1931).—Italian glass features wrought-iron supports for vases, etc. This Roman glass comes in blue, amethyst, amber, and green. It is all mouth blown by skilled craftsmen. E.P.R.

Colorful Czechoslovakian lamp. ANON. *Crockery & Glass Jour.*, **109** [5], 26 (1931).—The hand-cut glass base comes in several colors, amethyst, sapphire, ruby red, and crystal. E.P.R.

Preparation of brilliant gold and silver. V. E. TISHCHENKO AND S. A. SMIRNOV. *Zhur. Prikladnoĭ Khim.*, **3**, 1041–54 (1930).—Brilliant gold for the gilding of ceramic articles is best prepared by the method of Chemnitius (see *Ceram. Abs.*, **7** [6], 344; [12], 808 (1928)) which is slightly modified. A formula for preparing brilliant silver (Pd and not Ag is used) is also given. (*C.A.*)

Crystal glazes. III. J. WOLF. *Sprechsaal*, **64** [22], 409–13 (1931); for Parts I and II see *Ceram. Abs.*, **10** [9], 621 (1931). W.M.C.

Design problems of the tableware industry. ARTHUR BAGGS AND MARION L. FOSDICK. *Jour. Amer. Ceram. Soc.*, **13** [5], Part II, 11–33 (1930); *Design*, p. 249 (April, 1931); p. 1 (May, 1931); for abstract see *Ceram. Abs.*, **9** [3], 150 (1930); see also *ibid.*, **10** [3], 166 (1931). (*D.I.*)

Art of the under-sea world. JEAN CASSOU. *Art et Décoration*, pp. 143–50 (May, 1931).—The under-sea world offers a variety of motives for the decorator. (*D.I.*)

Lost magic. O. S. *Deut. Kunst & Dekoration*, pp. 111–12 (May, 1931).—Under the heading of "Lost Magic," stoppered bottles clear as cylindrical crystal or crossed with diagonal threads are described with other work of the Bimini Werkstatte, Vienna. (*D.I.*)

Interior walls of clay. II. ANON. *Brick Clay Rec.*, **79** [1], 26–27 (1931).—Additional photographs illustrating the use of clay tile, glazed and unglazed, for walls, floors, and ceilings, as well as decorations in interiors of various types of buildings, are presented. For Part I see *Ceram. Abs.*, **10** [9], 648 (1931). E.J.V.

Lac decoration on flowerpots. F. WURTS. *Keramos*, **10** [13-14], 353–54 (1931).—

The manufacture and lacquering of flowerpots of white and red ground are discussed. See also *Ceram. Abs.*, **10** [3], 202 (1931). M.V.K.

Artist tours the potteries. IV. ANON. *Pottery Gaz.*, **56** [650], 1118 (1931).—The application of glaze to pottery by the dipping and spraying processes is described in detail and illustrated. For Part III see *Ceram. Abs.*, **10** [8], 539 (1931). E.J.V.

Modern pottery. H. VARNUM POOR. *Design*, **32** [9], 214 (1931).—The form and enrichment of pottery is controlled by the artist. The method of underglaze decoration allows subordination of technique, keeping clear the essential point which is judgment of relations in color and form. Illustrated. E.B.H.

Rich porcelain set. ANON. *Crockery & Glass Jour.*, **109** [5], 26 (1931).—A Sèvres porcelain set in French design includes hand-painted miniatures featuring colorful scenery and figures suggesting the famous Watteau art. It may be had in red, blue, or green backgrounds. E.P.R.

Old Worcester painted porcelain in decoration. EDWARD WENHAM. *Arts & Dec.*, **35** [3], 20 (1931).—Worcester decoration features good ground colors, the most prevalent being a rich, deep blue often called scale blue because of its usual diaper or fishscale pattern. Turquoise, apple green, maroon, and canary yellow are fairly common ground colors, often treated with panels "in reserve," *i.e.*, panels left white to be painted later by the artists with scenic or floral decoration. Series were often made, the titles being printed or impressed on the underside of the article. Transfer-print method was also used. Illustrated. E.B.H.

Artistic majolica of Antonio Piermatteo. G. MILANI. *Corriere Ceram.*, **12** [6], 270–71 (1931). M.V.K.

Crafts of the Netherlands. BLANCHE NAYLOR. *Design*, **33** [1], 2–3 (1931).—Ceramics from Holland are arousing interest in this country. The introduction about 1600 of the highly developed Delft ware into Holland is a semimystery. It is a fine buff-colored clay dipped after first firing in white tin enamel, thus forming a ground for painted decoration, after which it is covered with transparent lead glaze and fired the second time. It is a faience of the same type as the old Italian majolica. Some unique and almost bizarre designs have been evolved. In glass the decorative effects excel, including bubbles, engraving, etching, enameling, and combinations of straight and curved lines made by means of both blowing and molding. Types of cased glass in which layers of various colored glass are carved to show several contrasting or blending shades are outstanding. Illustrated. E.B.H.

New table service. ANON. *Deut. Kunst & Dekoration*, pp. 126–31 (May, 1931).—A new table service of simple line and beautiful form is designed by Paul Borner and made at the State Porcelain Manufacture, Meissen, Germany. (*D.I.*)

Restoring china. FREDERICK DANA HAWES. *American Mag.*, **62** [2], 79 (1931).—A brief sketch of Nathan S. Hill, one of the few Americans left in the trade of restoring old china, is presented. His equipment and examples of his work are discussed. Illustrated. E.J.V.

Cream color. HARRY BARNARD. *Christian Sci. Mon.*, **23** [206], 7 (1931); reprinted from *Chats on Wedgwood Ware*.—The son of Asthury is accredited with making the first cream colored ware. About 1725 he mixed marl and flint and at a later date carefully prepared and blended the finest native clay and flint. This was again improved by Aaron Wedgwood, and Enoch Booth of Tunstall, the latter being the first potter who fired his ware twice. When Wedgwood settled in the Ivy House Works he concentrated for a period upon cream color only. The delicacy and finish of his ware induced many imitators to follow him. E.J.V.

Oriental pottery at the Cleveland Museum of Art. GRACE V. KELLY. *Cleveland Plain Dealer*, **90**, No. 207 (1931).—Outstanding among the pieces of Persian pottery in

the John Huntington collection are a 13th Century bowl and a cup from Rhages. The bowl is ornamented in blue-violet against a background glaze of rich bluish-green. The cup is tall and deep with a crackle glaze. Tiny figures on it are inclosed in panels of Persian ornament in subdued colors which give an effect of jewel-like richness. Illustrated. E.J.V.

Benton's murals in New York. C. A. GLASSGOLD. *Atelier*, **1**, 55–58 (1931).—The New York School for Social Research has nine panels by Thomas Benton representing the recreational and occupational activities of America. H.H.S.

Famous Wedgwood vase for Etruria Museum. ANON. *Pottery Gaz.*, **56** [650], 1142 (1931).—A valuable black basalt encaustic-painted vase which has become known historically as the "Canopic" Vase, originally made by Josiah Wedgwood in 1790 for presentation to Erasmus Darwin, has been presented to Josiah Wedgwood & Sons for their Etruria Museum by Herbert Goode. E.J.V.

Chinese miniature works of art. LADY INGRAM. *Connoisseur*, **87**, 300–305 (1931).—The collection consists of pieces none of which is more than 5 in. high. Illustrated. H.H.S.

New discoveries in early Greek art near Corinth. H. PAYNE. *Illus. London News*, **178**, 748–49 (1931).—The British School at Athens has made further discoveries at the temple of Hera. The pottery found depicts hounds, birds, a swan, and a woman spinning. See also *Ceram. Abs.*, **10** [4], 249 (1931). H.H.S.

Neo-Persian palaces at Kish. S. LANGDON. *Illus. London News*, **178**, 697 (1931).—Pottery and mural plaques found are illustrated. The plan of the palaces was like a Christian temple. H.H.S.

Dragon relief from the Ishtar Gate of Babylon. ANON. *Amer. Mag. Art*, **22** [6], 485 (1931).—The Detroit Institute of Arts has received as a gift from the Founders Society a relief of glazed tile which formed part of the walls of Babylon in the time of Nebuchadnezzar. It is the only dragon relief in this country. Illustrated. E.B.H.

Bowls used by the Romans. ANON. *Pottery Gaz.*, **56** [650], 1095 (1931).—Two bowls, terra sigillata or Samian, one figured and the other plain, used by the Romans in Chester-le-Street, Durham, 1800 years ago have been found. One is the work of Advocisus, a potter of Leboux, in Central Gaul, and the other of Belsius, a potter of Rheizabern. E.J.V.

Royal La Granja glass. CATHERINE MORAN. *Connoisseur*, **87**, 282–88 (1931).—The coming of the French Bourbons to the throne of Spain in the 18th Century resulted in the royal factory at La Granja (1728). A century later a branch was founded at Puebla, Mexico. H.H.S.

BOOKS

Fine Art, 1931. ANON. The Studio, London, 1931. Price 11s 6d. This is the first issue of an annual which is planned to form a world survey of collecting. H.H.S.

Catalogue of English Porcelain, Earthenware, Enamels, and Glass Collected by Charles and Charlotte Schreiber. Vol. II. Earthenware. BERNARD RACKHAM. Reviewed in *Connoisseur*, **87**, 321 (1931); for abstract see *Ceram. Abs.*, **9** [8], 609 (1930). H.H.S.

Art of Pottery. IRMA GALL AND VIVIAN VAN ETTA. Reviewed in *Ceram. Age*, **17** [2], 94 (1931); for review see *Ceram. Abs.*, **10** [7], 531 (1931). R.G.M.

Romance of the British Museum. W. H. BOULTON. Sampson Low & Co., London, 1931. Price 12s 6d. Reviewed in *Illus. London News*, **178**, 684 (1931). H.H.S.

Romance of Archaeology. W. H. BOULTON. Reviewed in *Illus. London News*, **178**, 684 (1931); for abstract see *Ceram. Abs.*, **10** [3], 170 (1931). H.H.S.

Ancient Civilizations of the Andes. P. A. MEANS. xviii + 586 pp. Charles Scribner & Sons, New York, 1931. Price $7.20. Reviewed in *Times Lit. Supp.*, **30**, 339 (1931).—The pre-Columbian people of America were as skilful as any in the Old World down to the Renaissance. H.H.S.

The Art of Egypt through the Ages. Edited by E. DENISON ROSS. 354 pp. The Studio, London, 1931. Price 2 guineas. Reviewed in *Times Lit. Supp.*, **30**, 341 (1931).—Essays on particular periods and special subjects are given by a group of *savants*. H.H.S.

Corinth. Vol. III, Part I. Acrocorinth. C. W. BLEGEN, O. BRONEER, R. STILLWELL, AND A. R. BELLINGER. xiv + 75 pp., 8 plates. Harvard Univ. Press, 1931. Price $5.00. Reviewed in *Times Lit. Supp.*, **30**, 378 (1931).—The results of excavations conducted by the American School of Classical Studies at Athens are recorded. The presence of geometric pottery shows that the history of the citadel of Acrocorinth began early in the Iron Age. H.H.S.

PATENTS

Design for bottle. ROYDEN A. BLUNT. U. S. 84,676 and 84,677, July 21, 1931. JOHN H. DAVIS. U. S. 84,682 and 84,683, July 21, 1931.

Design for jar. EDWIN W. FUERST. U. S. 84,690, July 21, 1931.

Design for teapot, etc. LUCIEN ANDUZE. U. S. 84,774, Aug. 4, 1931.

Design for tumbler, etc. EDWARD E. BARTLETT. U. S. 84,775, Aug. 4, 1931. ALBERT H. NICHOLSON. U. S. 84,792, Aug. 4, 1931.

Design for covered dish, etc. LUCIEN ANDUZE. U. S. 84,802, Aug. 11, 1931.

Design for plate, etc. HARRY J. WAIN. U. S. 84,861, Aug. 11, 1931. GEORGE WESP. U. S. 84,865, Aug. 11, 1931.

Design for platter, etc. GEORGE WESP. U. S. 84,863, Aug. 11, 1931.

Design for cup, etc. GEORGE WESP. U. S. 84,864, Aug. 11, 1931.

Design for casserole, etc. GEORGE WESP. U. S. 84,866, Aug. 11, 1931.

Composition of matter. AGNES MULVILLE. U. S. 1,802,442, April 28, 1931. A composition of matter containing lardite, silica, and china clay ground to a fine flour, a compound of salt, tartaric acid, sulphate of ammonia and water, and linseed oil, the whole being commingled by agitation.

Decorating articles of pottery, etc. HEINRICH MARMORSTEIN. U. S. 1,818,729, Aug. 11, 1931. In a process, the steps of covering an article having a dull-glazed surface with a coat of so-called liquid bright gold, drying the coat in the atmosphere, covering the gilded surface entirely with a coat of a solution consisting of Epsom salt dissolved in beer, drying the second coat in the atmosphere, firing the article in a kiln at liquid gold fire, leaving the article for about three hours in the kiln for cooling, and bathing the article in lukewarm water.

Cement, Lime, and Plaster

Chemistry of cement. SESTINI. *Giorn. chim. ind. applicata*, **13** [6], 297 (1931).—In a lecture before the Italian Chemical Society at the plant of the "Italcementi" at Bergamo, S. discusses the true composition of "alite" and the contribution of the Italcementi laboratory to the question. Its determination of distinctly recognizable crystals of alite in products without alumina content (a fusion of bicalcium ferrite), confirms the opinion of Le Chatelier of alite as a tricalcium silicate. On the basis of these results and from analytical data, the Italcementi estimates the characteristics of a cement based on the calcareous modulus (the relation between the lime combined with the silica and the silica itself) from which it is easy to calculate the quantity of

tricalcium silicate which can be retained in a well-prepared clinker. A description of the research laboratory of the Italcementi is given. See also *Ceram. Abs.*, **9** [8], 685 (1930). M.V.K.

Determination of the cement content of cement-lime mortars. THOMAS F. MULLAN AND EUGENE A. LEDYARD. *Rock Prod.*, **34** [16], 66–67 (1931).—The present methods for the determination of the cement content of cement-lime mortars are based on the amount of soluble silica in the hydrated mortar. The authors give calculations and an analytical procedure to remove the error due to the soluble silica in the sand present. Data are presented on some experimental mortars and actual cement sand ratios are compared with the ratios obtained by their method. A table showing variable amounts of soluble silica in sand is included. W.W.M.

Determining the specific gravity of cement. KARL E. DORSCH. *Rev. mat. constr. trav. pub.*, No. 260, pp. 185–87 (1931); for abstract see *Ceram. Abs.*, **9** [9], 791 (1930). M.Y.H.

Influence of the fineness of Portland cement on its properties. P. FILOSSOFOV. *Rev. mat. constr. trav. pub.*, No. 259, pp. 140–45 (1931); see also *Ceram. Abs.*, **9** [9], 711 (1930). M.Y.H.

Constitution of Portland cement studied by X-ray method. L. T. BROWNMILLER AND R. H. BOGUE. *Concrete*, **38** [2], 85; [3], 89 (1931); for abstract see *Ceram. Abs.*, **10** [2], 97 (1931). (*Jour. Amer. Concrete Inst.*)

Effect of grinding on setting time of cement. K. KOYANAGI. *Zement*, **20** [5], 467–69 (1931); *Pit & Quarry*, **22** [9], 68 (1931).—K. reports that a long period of grinding of coarse clinker in a small laboratory mill, using large steel balls, makes the resulting cement rapid-setting. The exact cause of the rapid setting in consequence of the long period of grinding could not be completely determined from the investigation. See also *Ceram. Abs.*, **9** [11], 912 (1930). E.P.R.

Gypsum and gypsum products manufacture. XI. Physical testing of gypsum products. S. G. MCANALLY. *Rock Prod.*, **34** [15], 54–56 (1931).—McA. deals with methods of testing calcined gypsum for fineness, consistency, setting time, and tensile strength. Particular attention is paid to factors which affect setting time. A summary of the probable causes of complaint in regard to gypsum plasters and stuccos concludes the article. For Part X see *Ceram. Abs.*, **10** [8], 543 (1931). W.W.M.

Researches on the rotary kiln in cement manufacture. XXIII. GEOFFREY MARTIN. *Rock Prod.*, **34** [15], 38–40 (1931).—M. describes the effect of internal radiation and convection on slurry moisture, showing that within certain limits the percentage of moisture in a slurry may be varied without altering the fuel consumption per 1 lb. of clinker. For Part XXII see *Ceram. Abs.*, **10** [9], 625 (1931). W.W.M.

Development of fused-cement kilns. E. SCHIRM. *Zement*, **20** [6], 118–23 (1931); *Rock Prod.*, **34** [15], 88 (1931).—S. describes briefly the design and disadvantages of kilns for clinkering fused cement and gives cross-sections. W.W.M.

Progress in acidproofing. THIEL. *Chem. Fabrik*, No. 30, p. 317 (1931).—The acidproof cement "Hoechst" is described. The usual water-glass cements harden only on their surface, while "Hoechst" hardens quickly throughout the whole mass and shows higher chemical and mechanical resistance. It widens the range of use of acidproof cement, being used for erection of walls, for machine foundations, waste shafts, etc. J.G.T.

Table and chart for proportioning the mix. ARTHUR T. SNYDER. *Rock Prod.*, **34** [11], 72–73 (1931).—S. presents a table and chart for proportioning a slurry too high in lime and one too low in lime to give the mixture desired. Examples are given and no calculations are required. W.W.M.

Blending system at dry-process plant provides uniform raw mix. DEWEY PORT-

LAND CEMENT CO. *Rock Prod.*, **34** [15], 25–31 (1931).—Quarrying, crushing, raw grinding, blending, clinkering, and grinding operations are described in detail. W.W.M.

History of the Roman cement industry in central Europe. C. R. PLATZMANN. *Rock. Prod.*, **34** [16], 46–47 (1931).—P. says the celebration in 1924 of the 100th jubilee of the invention of Portland cement was in error. The cement produced by Joseph Aspdin in 1824 was really Roman cement which had been sintered. Portland cement was first produced by Isaac Charles Johnson in the White plant, by sintering a raw mix. P. states that several men did work close to that of Aspdin at previous dates, but he named his product Portland cement merely because it resembled the Portland building stone in England. The raw materials for and production and uses of Roman cement in central Europe are discussed. Some of this cement competed with Portland cement as late as 1882. The composition of one Roman cement produced in Bavaria is SiO_2 22.4%, Al_2O_3·Fe_2O_3 13.6%, CaO 57.7%, MgO 1.6%, MnO_2 1.8%, and CO_2 2.1%. Directions for various uses of Roman cement are cited. A bibliography is included. W.W.M.

New standard specifications for binding materials in Rumania. A. STEOPOE. *Tonind.-Ztg.*, **55** [57], 832–33 (1931).—A short review on the new standard specifications is given covering lime, usual and high-quality cements, and plaster of Paris. W.M.C.

Production of masonry, natural, and pozzuolana cements in 1930. ANON. *Pit & Quarry*, **22** [9], 58 (1931).—Statistics of hydraulic cements, other than Portland cement, which include masonry, natural, and pozzuolana cements show a production of 1,792,083 bbl. in 1930, representing a decrease of 18.9% in comparison with 1929. E.P.R.

BOOKS

Waterproofing against Ground Water. (Grundwasser-Abdichtung.) J. SCHULTZE AND W. SICHARDT. W. Ernst & Sohn, Berlin. Price 5 Rm. *Mining & Met.*, **12** [295], 14 (1931).—In this concise review of practical methods for waterproofing mortar and concrete in underground structures, the advantages and disadvantages of different methods are described and directions are given for their use. E.J.V.

Electric Furnaces for Fused Cement. (Elektroschmelzzement.) M. KAUCHTSCHISCHWILI. Published by Siemens and Halske A.-G., Berlin-Siemensstadt. Translated by John H. D. Blanke in *Rock Prod.*, **34** [8], 34–38 (1931); for abstract see *Ceram. Abs.*, **10** [4], 252; [6], 408 (1931). W.W.M.

Enamels

Pickle room control for porcelain enameling plants. W. C. LINDEMANN. *Jour. Amer. Ceram. Soc.*, **14** [9], 631–33 (1931); see also *Ceram. Abs.*, **10** [9], 627 (1931).

Progress report on determination of crystalline compounds causing opacity in enamels by X-ray methods. A. I. ANDREWS, G. L. CLARK, AND H. W. ALEXANDER. *Jour. Amer. Ceram. Soc.*, **14** [9], 634–39 (1931).

Smelting enamels. A. I. ANDREWS. *Fuels & Fur.*, **9** [3], 367 (1931).—Smelting involves the melting together of the raw materials entering the enamel composition until a fairly uniform glass is formed. The successful accomplishment of this is dependent on the thorough mixing of the raw materials, the proper heating, and the distribution of heat through the batch. A temperature applied too slowly will not give ideal conditions as this first melt will then react slowly and may in itself volatilize, leaving the remaining batch more refractory. If an enamel is melted too rapidly it is difficult to obtain good heat distribution; *i.e.*, the batch melts first in the hotter portions and

when the heat has penetrated to the inside of the batch there is danger of the initial melt being oversmelted. A batch heated uniformly but too quickly will sometimes cause an excessive volatilization of the fluxes because the refractory materials have not had time to go into solution in the already melted fluxes. These refractory materials in the solution raise the fusion and boiling point. A.E.R.W.

White ground enamels. W. KERSTAN. *Sprechsaal*, **64** [30], 557–59 (1931).—A review is given on experiments of different authors to find a white ground enamel. The main problem is to obtain a pure metallic surface which allows a successful firing of the ground enamel. W.M.C.

Luminous enamels. L. VIELHABER. *Emaillewaren-Ind.*, **8** [29], 227 (1931).—Luminous enamel for lettering on signs is made from a specially prepared and fired batch containing 10 to 20% luminous zinc sulphide. It contains no arsenic, antimony, lead, or coloring oxides, but is used in the original color, greenish, for the lettering which may be outlined in other colors to aid legibility in the daytime. This enamel lasts from 2 to 10 years. M.V.K.

Clay for enamel. L. VIELHABER. *Emaillewaren-Ind.*, **8** [29], 226–27 (1931).—Practical tests on the properties of a clay for enamel, *e.g.*, the capability of the clay to hold the finely divided enamel in suspension in water, the adhesive power, degree of fatness, turbidity action, and grain size, should be made to determine the fitness of a clay for enamel applied by the wet process. M.V.K.

Vitreous enameled iron used by railroads. ANON. *Aciers spéciaux*, **6**, 215–18 (1931).—The uses of enameled iron on French railroad coaches are discussed. A.J.M.

Increase in diversity of enameled objects. FRED MCC. BURT. *Ceram. Ind.*, **17** [2], 111–12 (1931).—B. stresses the opportunity of plants to increase the diversity of uses of enameled objects and cites a plant which makes specialties and orders besides its regular line. He suggests the miscellaneous use of enameled steel sheets in patterns, enameled toys, serving trays, and shower stalls. Some use should be found for small enameled articles which could be made from steel scrap, possibly some game or toy. W.W.M.

Time tables for sheet-metal enameling. WILHELM LINKE. *Emaillewaren-Ind.*, **8** [25], 194–96 (1931).—Time tables for charges are given. See also *Ceram. Abs.*, **10** [9], 627 (1931). M.V.K.

Equipment for cleaning metal. VII. R. W. MITCHELL. *Metal Cleaning & Finishing*, **3** [7], 549–52 (1931).—Following a brief discussion of the theory of electrical resistor heating, several different types of electric heaters are described which are adaptable to heating tanks for pickling solutions, etc., used in cleaning metals. Illustrated. For Part VI see *Ceram. Abs.*, **10** [9], 627 (1931). E.J.V.

Cleaning sulphuric acid tanks. FREITAG. *Emaillewaren-Ind.*, **8** [26], 201–202 (1931).—In cleaning sulphuric acid tanks, it is imperative for the workman who enters the tank to wear a gas mask because the deadly poisonous arsenic hydride is present in a gaseous form. This gas should be diluted and drawn off by a strong current of fresh air forced into the boiler during cleaning. M.V.K.

Danger of lead poisoning in the enameling industry. G. S. ERENBURG. *Arb. Leningrad. Inst. Gewerbehyg. Unfallverhütung*, **3** [4], 231–39 (1930).—Enameling of watches and jewelry is chiefly considered. (*C.A.*)

Enamel institute's technical consulting service. ANON. *Ceram. Ind.*, **17** [2], 130 (1931).—The Porcelain Enamel Institute, Chicago, announces the addition of a Manufacturers' Technical Consultation Service to its other activities. W.W.M.

BOOK

Handbook of Press Technique. (Handbuch der Ziehtechnik.) W. SELLIN. J.

Springer, Berlin. Price 32 Rm. *Mining & Met.*, **12** [295], 16 (1931).—This is a practical treatise on the press working of sheet metal. The materials, machines, and tools are discussed in detail, and the selection of processes and the design of dies, punches, etc., are treated at length. E.J.V.

PATENTS

Enameled-iron plumbing fixture. CHARLES R. CRANE. U. S. 1,815,705, July 21, 1931. In a plumbing fixture, a receptacle formed of cast metal having a coating of vitreous enamel thereon, the receptacle having an upstanding wall provided with an elongated overflow orifice, the orifice being provided with an elongated horizontally extending upper edge, portions of the wall at the sides and bottom of the orifice extending outwardly and upwardly of the receptacle and providing an elongated horizontally extending lip of substantially the same thickness as the wall thickness and terminating in a lower, elongated, horizontally extending edge disposed rearwardly of the upper edge of the orifice whereby the orifice is substantially concealed from the view of a casual observer, the coating of vitreous enamel extending over the interior side of the receptacle including the lip.

Furnace for baking enameled products. NAAMLOOZE VENNOOTSCHAP: FERRO ENAMELING CO. OF HOLLAND. Fr. 696,504, May 20, 1930. (*C.A.*)

Muffle furnace for enameled objects. MARCEL DUCROQUET AND RENÉ GILLAIN. Fr. 697,610, June 18, 1930. (*C.A.*)

Enamels on iron. IGNAZ KREIDL. Fr. 699,975, Aug. 2, 1930. In enameling Fe, the first adhesive for the enamels is formed by the application on the surface of the Fe of a H_3PO_4 solution or pseudo solution of salts or nonvolatile acid combinations of adhesive metals, particularly those of Ni and Co. (*C.A.*)

Grate for supporting enameled goods during firing. METALL-INDUSTRIE J. KLEFISCH. Ger. 524,476, Feb. 22, 1929. (*C.A.*)

Glass

Physical properties of glasses as function of their composition. V. G. GEHLHOFF, H. KALSING, AND M. THOMAS. *Z. tech. Physik*, **12** [7], 323–44 (1931).—Glasses which were made turbid by means of fluorides were investigated when the silica was replaced by adding different amounts of MgO, CaO, SrO, BaO, ZnO, PbO, B_2O_3, and Al_2O_3. Besides this, the amount of sodium and fluoride was changed and in some melts sodium was replaced by potassium. The transparency, reflexion, and absorption of the glasses were measured and the number and size of turbid particles were determined. The transmissibility diminishes in the following sequence: MgO,- CaO,- SrO,- BaO,- ZnO,- and PbO-containing glasses. Increase of turbidity was obtained by adding fluoride and, in most cases, by decreasing the sodium content. Glasses with PbO have only small absorption losses when highly turbid. Small additions of Al_2O_3 increase the turbidity, whereas larger additions make the glasses denser again. For the other additions, corresponding results were obtained. A general rule seems to be that it is easier to make a glass turbid if it is highly transmittent. The way in which the fluorides are introduced into the glass is not important, provided that the composition of the glass is not changed. When varying size and number of particles, it was found that points of equal transparency or equal reflexion seem to lay on hyperbolas. A bibliography on the problems investigated is attached. W.M.C.

Constitution of glass based on the laws of solutions. OSCAR KNAPP. *Jour. Soc. Glass Tech.*, **15** [58], 140–52 (1931).—K. examines critically the hypotheses of others and

elaborates new hypotheses based on practical facts. Efforts to define limits of composition of glasses by means of an oxide formula are not in harmony with modern physical and chemical knowledge of solutions. Experimental facts are not in accordance with Hermann's hypothesis of silicate constitution. Devitrification studies do not reveal the probable constitution of glasses. Keppeler's hypothesis of monohexasilicate is discussed. A hypothesis regarding the constitution of glass must satisfy the following conditions: (1) The glass is composed of silicates in which acid or basic oxides may be dissolved. (2) There is no definite relation between the constitution and physical properties of glass. (3) The component silicates of a given type of glass are definite in kind through the range of possible composition. K. considers glass as a genuine solution of highest possible silicates in which free silica is most often dissolved. G.R.S.

Fusing glass parts. H. FISCHER. *Glastech. Ber.*, **9** [4], 204–11 (1931).—F. defines welding as the fusing of glasses of the same composition and soldering as the joining of different glasses by means of an intermediate glass. The fusing of glass of different composition and color has been used widely for artistic glassware (glass mosaic, etc.) where surfaces can be joined. It is more difficult to join glasses if the contact between them consists only of lines, *e.g.*, in glass tubing. It is possible (Ger. 496,089) to join the different tubes by heating "soldering" glass between them in such a way that the liquid "solder" will draw the tubes together by surface tension, covering the interstices between the tubes completely and giving a rigidity comparable to a solid glass itself. This is possible only if the expansion coefficients of the two glasses are not too different. The strain set up by joining different glasses can be made visible by joining long strips of glass and observing the curvature due to the strain. This phenomenon can be used also to measure the expansion coefficient of different glasses; a change to 0.8 soda in the batch has been detected in this way. Different applications of equipment using soldered tubing are given (pipette holders, flower stands, etc.). K.L.-H.

Use of ammonium sulphate in glassmaking. A. E. J. VICKERS, G. H. WHITING, R. MILLER, AND V. BATES. *Jour. Soc. Glass Tech.*, **15** [58], 166–72 (1931).—Additions of 5 parts of ammonium sulphate to 1000 parts of sand do not affect melting or refining times, but 10 parts decreased the times of both, causing seed to gradually disappear. Fifteen parts of this salt cause seed to disappear almost at once, the seed growing smaller, not larger. The glass increases in brilliancy, changing in color from dull yellowish-green to a brilliant bluish-green. A great increase in fluidity of the glass is noted together with a greater rate of solution of the batch. The surfaces of bottles made of this glass are softer and more easily scratched, but the bottles are tougher and not so brittle. Bursting pressures of bottles made from the ammonium sulphate glass are higher than those prepared from glass containing none of this salt. The amounts of SO_3 retained by the glass are small compared to that added as ammonium sulphate, and the amount of soda ash blown over from the batch is small. G.R.S.

Use of ammonium sulphate as accelerating agent in glassmaking. M. PARKIN, W. J. A. WARREN, AND W. E. S. TURNER. *Jour. Soc. Glass Tech.*, **15** [58], 153–66 (1931).—The glasses investigated vary in Na_2O content from 13.1 to 16.8% and in CaO from 8.5 to 13.8%. One glass contained 1% of B_2O_3 and another was colored by additions of iron and manganese oxides. Ammonium sulphate up to 10 parts per 1000 of sand has an accelerating action on both the melting and refining processes. In general this salt is more effective in both melting and refining than is Na_2SO_4. The ammonium salt appears to undergo some reaction with sodium salts during melting of the batch and to leave residual sulphate in the glass, the ammonia being almost entirely volatilized. The stirring effect of the escaping gas is advantageous. G.R.S.

Influence of manganese oxide on some properties of glass. A. A. CHILDS, VIOLET DIMBLEBY, F. WINKS, AND W. E. S. TURNER. *Jour. Soc. Glass Tech.*, **15** [58], 172–

84 (1931).—Three series of glasses were tested: (1) SiO_2 72, CaO 10, and Na_2O 18, (2) with 2% Al_2O_3 introduced for an equal weight of SiO_2, and (3) with 2% SiO_2 replaced by an equal amount of Fe_2O_3. In each series Na_2O was replaced progressively by MnO_2. The per cent of MnO_2 in the glass, the melting time from initial charge, refining time subsequent to complete melting, working temperature, and glass color are shown in a table. Iron oxide (2%) increases the melting rate. The colorless glass is difficult to get seed-free, but additions of a little coloring oxide overcome this difficulty, 0.5% MnO being sufficient. Annealing temperatures, not determinable by optical means because of the dense color, may be derived from thermal expansion curves. There was a general fall in thermal expansion as MnO was introduced, with the replacement of Na_2O. Tests were made on resistance of the glasses to the action of boiling water, HCl, Na_2CO_3, and NaOH. See also *Ceram. Abs.*, **9** [11], 924 (1930). G.R.S.

Density of sodium metasilicate-silica glasses. F. WINKS AND W. E. S. TURNER. *Jour. Soc. Glass Tech.*, **15** [58], 185–90 (1931); for abstract see *Ceram. Abs.*, **10** [9], 630 (1931). G.R.S.

Modifications for the method of direct determination of sodium sulphate in salt cake. A. NOËL. *Rev. belge ind. verrières*, **2**, 81–82 (1931).—The complete analytical procedure is given. A.J.M.

Flow tests in small glass tanks. A. L. MARDEN. *Jour. Soc. Glass Tech.*, **15** [58], 119–28 (1931).—The indicator used for tracing currents of glass was cobalt-blue glass or cobalt oxide. The first test was made on a small oil-fired tube making tank, the glass being ladled into it at the rate of 360 lb./hr. After adding the blue glass till it appeared at the working end, the heat was taken off and the glass quickly chilled by air blasts. A diagram shows the flow lines in the tank. The ladled glass sank to within 6 in. of the bottom, traveled across it, and took the most direct route to the outlet, a condition favorable to formation of cordy glass. By means of a new flow system, the stagnant layer at the bottom was eliminated. Diagrams show the arrangement of the tank. A flow test was made in a tank supplying glass to a Westlake bulb-blowing machine. A diagrammatic sketch shows flow lines in this 10-T. glass tank. The convection current caused a long spiral flow in the left-hand side, while on the right, the glass did not appear to move forward but merely rotated as a long cylinder. Tests on a small-size tank used to supply glass to a Danner tubing machine were disappointing. See also *Ceram. Abs.*, **9** [4], 267 (1930). G.R.S.

Investigation of the flow of glass in tank furnaces by the use of barium oxide. E. J. C. BOWMAKER AND J. D. CAUWOOD. *Jour. Soc. Glass Tech.*, **15** [58], 128–40 (1931); *Ceram. Ind.*, **17** [2], 129 (1931); for abstract see *Ceram. Abs.*, **10** [9], 630 (1931). G.R.S.

Adsorption of gases by glass walls. VI. Air and carbon monoxide. M. CRESPI AND E. MOLES. *Anales soc. españ. fís. quím.*, **27**, 529–34 (1929).—By use of the apparatus and method previously described, determinations with air gave $A_e = 0.94 \times 10^{-9} p^{0.5}$ g. per sq. cm. between 1 and 0.25 atmospheres at 20°, and with CO, $A_e = 1.03 \times 10^{-9} p^{0.5}$ g. The quantity of air adsorbed by a 1-liter flask under ordinary conditions is only 0.000012 g., and the quantity of CO, 0.000014 g. **VII. Ethylene.** *Ibid.*, **28**, 448–60 (1930).—C_2H_4 was prepared by dehydrating EtOH by 80% H_3PO_4, S impurities being avoided. Experimental results could be expressed by the Freundlich equation. The Schmidt and Perrin-Langmuir equations give quite different results. The coefficient of adsorption of C_2H_4 at 1 atmospheric pressure, referred to the weight of a normal liter, is 0.38×10^{-4} g. Only the empirical Burt rule seems to apply generally to the relations between the adsorption values by glass, the solubility, the dipolar moment, etc. **VIII. Hydrochloric acid gas.** *Ibid.*, **29**, 146–57 (1931).—Adsorption of HCl by the glass walls of the flask used to determine the mass of the normal liter and

of the apparatus used to determine compressibility gave 1.74×10^{-4} g. at 760 mm. for a 1-liter flask, as the correction to be applied. The tests confirmed the McBain theory of both absorption or solid solution of gas on the glass surface, and adsorption on the surface. The course of both processes can well be expressed by the Freundlich adsorption equation. Results of others are criticized. For Part V see *Ceram. Abs.*, **8** [8], 573 (1929). (*C.A.*)

Solubility of tempered glass at different distances from the surface. S. I. IOFE. *Trans. State Inst. Testing Building Materials and Glass* [Moscow], No. 29, pp. 3–11 (in German p. 12) (1930).—The amount dissolved from prisms of fused borax was measured by the conductivity method. Uniform surfaces were obtained by grinding with emery powder and shielding with paraffin. The surface layer is less soluble than the inside layers. This shows that the surface layer is compressed and the inside expanded. There are far more expanded layers than compressed layers. At equal depths weaker tempered glasses show a greater solubility. The increase in solubility suggests a corresponding change in density and index of refraction. (*C.A.*)

Soluble glasses. ALBERT DEDECQ. *Rev. belge ind. verrières*, **2**, 59–60 (1931).—The manufacture, uses, chemical analyses, and physical properties of soluble silicates (water glass) are discussed briefly. A.J.M.

Note on heat-absorbing glass. A. F. DUFTON. *Jour. Soc. Glass Tech.*, **15** [58], 208–12 (1931).—In order to minimize high temperatures on sunny days inside a building with a glass roof or skylights, the use of a special absorptive glass has been advocated and the extent of the absorption of heat in relation to the amount of light transmitted has been taken as the test of efficiency. The fact that in absorbing heat the glass becomes warm and so communicates heat to the room is not taken into account. The use of double glazing is suggested. A table shows what may be expected from various forms of glazing. G.R.S.

Determination of the durability of glass by the test on powdered glass. M. THOMAS. *Rev. belge ind. verrières*, **2**, 82 (1931).—Ten grams of glass powder (diameters between 0.30 and 0.49 mm.) were placed in 100 cc. of water and heated at 100°C for 5 hr. A.J.M.

Viscosity and expansion of glass in the softening region. A. P. ZAK. *Trans. State Inst. Testing Building Materials and Glass* [Moscow], No. 29, pp. 13–24 (in German p. 25) (1930).—The viscosities of 9 commercial glasses were determined by the increase in length of a loaded glass rod at constant temperature. All the glasses showed breaks in the viscosity curve in the region 400 to 700° at a viscosity of $10^{12.9}$ c.g.s., corresponding to the change from viscous liquid to brittle solid, and at $10^{9.44}$ c.g.s., corresponding to the start of deformation. Similar breaks were found with the self-registering Chevenard apparatus. Curves for tempered glass are similar, but the breaks are at lower temperatures. (*C.A.*)

Thermal endurance of glass. M. A. BESBORODOV. *Glashütte*, **60**, 361 (1930); *Jour. Soc. Glass Tech.*, **14**, 282–83*A* (1930).—Previous work by B. (*Ceram. Abs.*, **9** [5], 341 (1930)) shows that in the case of laboratory ware the thermal endurance is a function of the ratio of the maximum thickness to the minimum thickness as well as dependent on the other physical properties in accordance with the formula adopted by V. Stott (*Chem. Abs.*, **19**, 1183). Rods of a borosilicate glass 8 cm. in length and of varying thicknesses were tested by quenching in water. The resistance to heat increased with decreasing thickness of the rods. Unannealed glass was more resistant than annealed. (*C.A.*)

Permeability of glasses to ultra-violet radiation. II. P. GILARD, P. SWINGS, AND A. HAUTOT. *Bull. sci. acad. roy. Belg.*, **17**, 362–68 (1931); for abstract see *Ceram. Abs.*, **10** [9], 630 (1931). (*B.C.A.*) **III.** *Rev. belge ind. verrières*, **2**, 50–54 (1931).—The

permeability to ultra-violet radiations increases with increasing percentages of silica. The glass, $6SiO_2 \cdot CaO \cdot Na_2O$, shows the highest transmission for soda-lime glasses. In potash-lime glasses the transmission is not influenced by variations in the lime content. For glasses of the type $6SiO_2 \cdot xCaO \cdot M_2O$ (M = Na or K; x having the values 0.8 to 1.2), the variations in lime content do not have much effect on the ultra-violet transmissions. Barium oxide added to a soda-silica glass reduces the transmission but not as greatly as lime does. In soda glasses variations in magnesia content do not greatly influence the transmission. Of the potash glasses, the normal glass, $6SiO_2 \cdot MgO \cdot K_2O$, shows the greatest transmission. Alumina increases the transmission of a soda-lime glass when it replaces part of the lime. The limit of transparency in a soda-lime glass and a soda-zinc-silica glass is 2700Å but the zinc glass shows a much greater absorption. **IV.** *Ibid.*, **2**, 74–79 (1931).—A series of glasses, $6SiO_2 \cdot RO \cdot xR_2O$, was made up. RO was CaO, BaO, or MgO. R_2O was Na_2O or K_2O and x varied from 0.8 to 1.2. The results were as follows: (1) In the soda-lime glasses, variations in soda content did not sensibly affect the transparency. (2) In the soda-baryta glasses, increasing the soda had an unfavorable effect. (3) In the soda-magnesia glasses, increasing soda did not influence the transparency. (4) In potash-lime glasses, variations in potash content did not have a marked effect on transparency, the glass, $6SiO_2 \cdot CaO \cdot K_2O$, seeming to give best results. (5) In potash-baryta glasses, increasing potash had a detrimental effect. (6) Potash, in glasses with either CaO or BaO as the RO group, produced better transparency than soda, with the lime glass being better than the baryta glass. The effect of boric oxide was studied on 3 series of glasses ($5SiO_2 \cdot CaO \cdot Na_2O$ + 0.2 to 1.5 B_2O_3, $5SiO_2 \cdot CaO \cdot K_2O$ + 0.2 to 1.6 B_2O_3, $5SiO_2 \cdot BaO \cdot Na_2O$ + 0.2 to 1.4 B_2O_3). The results showed that (1) in soda-lime glasses, increasing B_2O_3 decreased the limit of transparency; (2) in potash-lime glasses, variations of B_2O_3 had slight effect on the transparency; and (3) in soda-baryta glasses, variations in B_2O_3 did not influence the transparency. More light is transmitted in those glasses having the lowest B_2O_3 contents. Three glasses, $5SiO_2 \cdot 0.25CaO \cdot 0.25MgO \cdot 0.25BaO \cdot 0.25Al_2O_3 \cdot Na_2O$, were melted. To one of these 2% Sb_2O_3 was added; to another, 2% As_2O_3 was added. Both Sb_2O_3 and As_2O_3 diminished the limit of transparency, the effect of As_2O_3 being more marked. No marked difference in transparency was found in glasses $5SiO_2 \cdot 0.25MgO \cdot 0.25Al_2O_3 \cdot 0.5BaO \cdot Na_2O$ and $5SiO_2 \cdot 0.25MgO \cdot 0.25CaO \cdot 0.5BaO \cdot Na_2O$. Nickel oxide (%) added to a glass diminished the transparency. The presence of NiO in a soda-lime glass increased the absorption of light. NiO added to a soda-lime-alumina-silica glass did not materially affect the absorption. In a similar potash glass, the NiO at first increased the absorption, but decreased it slightly at the shorter wave lengths. In a soda-magnesia glass, NiO decreased the absorption; in the corresponding potash glass it increased absorption. No definite rule regarding NiO can be given since its effect depends on the type of glass. Cr_2O_3 decreased the limit of transparency and increased the absorption. In a glass, $6SiO_2 \cdot BaO \cdot K_2O$, the addition of Cr_2O_3 produced total absorption between 3820 and 3320Å and almost total absorption between 3320 and 2950Å. This occurred only when Cr, Ba, and K were present together. Cobalt oxide diminished the transparency. CoO increased the absorption in the glass, $6SiO_2 \cdot ZnO \cdot Na_2O$, but did not have much effect in the glass, $6SiO_2 \cdot BaO \cdot K_2O$. Manganese dioxide diminished markedly the limit of transparency and greatly increased the absorption in the glass, $6SiO_2 \cdot CaO \cdot Na_2O$. Iron oxide completely absorbed all light beyond 3250Å. Copper oxide had a similar effect. For Parts I and II see *Ceram. Abs.*, **10** [9], 630 (1931). A.J.M.

Defects of nepheline glass. V. V. WARGIN AND N. K. MATVEJEV. *Ceramics & Glass*, **7** [3], 5 (1931).—The defects caused by a change to a nepheline glass are discussed and explained, and means of avoiding them are indicated. Most of the defects

are due to a too rapid change-over and are only temporary. "Stones" were observed in large quantities and were found to be batch stones, *i.e.*, particles of nepheline, feldspar, and quartz. No devitrification was noticed. (*Trans. Ceram. Soc.* [Eng.])

Use of nepheline batch in the "Proletary" glassworks. SAMSONOW. *Ceramics & Glass*, **7** [3], 3 (1931).—A glass tank (Siemens system) was gradually changed in 6 days to a batch containing 35% nepheline. The preparation of the materials, charging, and temperature schedule were unchanged. The change was effected without difficulty. The nepheline glass had better working properties, but was darker in color. The method adopted in the change-over is described. (*Trans. Ceram. Soc.* [Eng.])

Glass and mica combined to make unique molding material. ANON. *General Electric Rev.; Amer. Glass Rev.*, **50** [43], 32 (1931).—A combination of ground mica and soft glass has resulted in the development of a molding material called "Mycalex." It consists of ground mica scraps mixed with an easily fusible glass in powder form, heated sufficiently to soften the glass, and then molded under hydraulic pressure while still hot and plastic. The substance is vitreous and impervious to both liquids and gases. It can be machined and finished by the usual operations of turning, sawing, drilling, tapping, filing, and polishing with high-speed tools. "Mycalex" is entirely inorganic and is not subject to carbonization, burning, softening, shrinkage, and other effects of overheating. Compared with transparent fused quartz, it has greater dielectric strength, greater specific gravity, a larger coefficient of expansion, and an equal tensile strength. E.P.R.

Photoelectric methods for measuring absorption curves of colored glasses. W. EITEL AND B. LANGE. *Glastech. Ber.*, **9** [4], 211–16 (1931).—After discussing the disadvantages of the old spectrophotometric methods and the shortcomings of the alkali photocell, the new cells developed by L. are described. These cells consist of a semiconductor (cuprous oxide, silver selenide, or lead sulphide) covered by a transparent metal electrode, and do not need any outside e.m.f. to move the electrons. The photocurrent can be measured directly with a sensitive galvanometer without any amplification. Photocurrent and photovoltage are proportional to the light intensity over a wide range, making these cells suitable for light intensity measurement. The cells are sensitive also to the far red where the alkali cell cannot be used any more. Special forms of the cell for use either in the optical bench or in the ocular of a microscope have been developed. The transparency of glasses is measured by the ratio of photocurrent with and without the absorbing material in the path of the light rays. For spectrophotometric investigations monochromators of different designs have been used, giving a definition of 1 to 10 mμ. For the most precise measurements such narrow slits have to be used as to necessitate the use of a highly sensitive galvanometer (2.10^{-10} *A*/mm. in 1.5 m. distance.) The minimum dimensions of the sample in the monochromator used could be made as small as 2 x 2 mm. Under suitable conditions it is possible to use even microscopically small samples. The thickness of the sample must be chosen to give the best ratio of photocurrents, $I : I_0 = 1:2$ to 1:5, since otherwise the precision of the measurements is diminished. As examples, the absorption curves of railroad signal disks are discussed. Heat-protecting glasses and a pure neodymium glass have also been investigated (the latter curve is an interesting example of the precision which can be reached with this method). It is possible to trace a curve containing 100 points in half an hour. K.L.-H.

Photoelectric measurements of transparency and color of optical glasses. W. EITEL AND B. LANGE. *Glastech. Ber.*, **9** [4], 216–18 (1931).—Absorption of optical glass of great transparency and pure color cannot be investigated by ordinary spectrophotometric methods even when using heavy layers. It can be investigated by the new photocell of L. in connection with the monochromator and a sensitive galvanometer. Glass

samples up to 20 cm. in length have been investigated. Four different optical glasses have been studied, barium glass, two flint glasses, and one crown glass. While all glasses show strong absorption in the violet, the properties of the yellow-green region are widely different. The crown glass shows only a small absorption. All glasses show absorption in the long-wave region because of the iron taken up from the part during the melting process. A white bottle glass seemingly completely transparent and colorless shows the typical absorption caused by iron. K.L.-H.

Modern colloidal colors. E. ZSCHIMMER. *Sprechsaal*, **64** [28], 521–24; [29], 539–42 (1931).—Different metals can be found as colloids in glass, *e.g.*, gold, copper, silver, lead, and arsenic. Old recipes to make colored glass by introducing these elements are given and discussed with modern explanations. Today, colloidal colors in glass are produced by introducing selenium or cadmium sulphite together with a mixture of cadmium and selenium. Sulphur and tellurium have an effect like selenium, whereas other elements such as manganese, iron, cobalt, and nickel are seldom used. Laboratory experiments have shown that other elements may form colloids in glasses. The importance of colloidal colors for the glass industry is pointed out and the reasons for the colors observed are discussed. Different factors causing changes in the colors of glasses are mentioned such as slow cooling, changes in composition of the glass, temperature changes, etc. A review of patterns in connection with these colors is given and the process of making different types of colored glasses for modern plants is discussed giving some batch compositions, results of physical investigations, coefficients of extinction, and spectra. W.M.C.

Sandblasting and its use for glassware finish. U. LOHSE. *Glastech. Ber.*, **9** [4], 197–204 (1931).—Sandblasting for the finishing of glass was discovered by accident. In the sixties an engineer observed that the pattern of the wire screen set before a window to stop the impact of sand was found neatly etched into the glass. The first patent, which was granted to B. C. Tilghman in 1871, used an arrangement containing the main principle underlying all the later developments: sand is sucked through a nozzle of an aspirator driven by compressed air and is forced in a stream mixed with the compressed air against the glass. Modern arrangements differ only by using steam or vacuum systems to aspirate the sand. For a fine finish, Mathewson introduced a mixture of sand and water, and for an extremely fine-etched grain, this mixture is used in a steam aspirator. The effective output in the different arrangements can be calculated from the following table:

Pressure sand blast:	$2^1/_2$–3 h.p., 5–6 sq. m./hr.
Steam sand blast:	5–8 sq. m./hr., using 65 kg. steam/hr.
Vacuum sand blast:	18–35 sq. m. (depending on the width of plate glass) for 10–15 h.p.

The dimensions of the holes depend on the thickness of the plate. It is believed that it is impossible to make any holes smaller than the thickness of the plate itself. In a plate 28 mm. thick, a hole of 42 mm. diameter can be made in 8 minutes, using a nozzle of 10 mm. diameter. In a plate 8 mm. thick, holes of 8 to 50 mm. diameter can be drilled in 12 to 45 seconds and in a plate 3 mm. thick, holes of 8 to 50 mm. diameter can be made in 8 to 35 seconds. K.L.-H.

Shrinking glue chips glass. ANON. *Popular Sci.*, **119** [3], 61 (1931).—By applying a thin coat of a shrinking glue, such as animal glue, to a lightly sand-blasted pane of glass, it is possible to produce an irregular-frosted pattern that diffuses the light but does not leave the glass transparent. Illustrated. E.J.V.

Safety glass. U. ARBENZ. *Glastech. Ber.*, **9** [5], 261–66 (1931).—Safety glass is manufactured at a rate per year of over 1,000,000 sq. m. in the U.S., 300,000 sq. m. in England, and only a few thousand square meters in Germany. Since the first patent of Wood in 1905 for joining glass plates to celluloid with Canada balsam, the well-known

method of Benedictus has been introduced by sealing celluloid between glass sheets coated with gelatin. This method, well known in America, has been discussed in great detail, special attention being given to the problems in manufacturing. Strain due to enclosures of foreign particles in the celluloid, influence of moisture, formation of bubbles in the celluloid due to excess alcohol, and especially the changing color of the celluloid under the action of sunlight are discussed. Recently experiments have been carried out using cellon (acetate cellulose) instead of celluloid since it is more resistant to sunlight. To avoid moisture, sealing of the safety glass is necessary when using celluloid or cellon. A new material is being introduced, of a rubber-like constitution (U.S. 1,748,079, see *Ceram. Abs.*, **9** [4], 273 (1930)) which is not being attacked by moisture. The possibility of the standardization of tests for safety glass is discussed. The paper is followed by a survey of German and French literature on hardened glass and unbreakable glass by R. Schultze. See also *Ceram. Abs.*, **10** [6], 419 (1931). K.L.-H.

Decolorization of glass. FRANK R. PESSERL. *Rev. belge ind. verrières*, **2**, 54–57 (1931); for abstract see *Ceram. Abs.*, **10** [8], 556 (1931). A.J.M.

Index of refraction of some soda-lime-silica glasses as a function of the composition. C. A. FAICK AND A. N. FINN. Bur. Stand., *Jour. Research*, **6** [6], 993–1002 (1931); R.P. 320; see also *Ceram. Abs.*, **10** [8], 550 (1931). R.A.H.

Ruby glass. W. HACKER. *Glas & Keram. Ind.*, **20** [25], 5 (1930); *Jour. Soc. Glass Tech.*, **14**, 249*A* (1930); for abstract see *Ceram. Abs.*, **9** [5], 342 (1930). (*C.A.*)

Glass problems. I. Glass as fourth state of matter. E. BERGER. *Z. tech. Physik*, **12** [7], 344–63 (1931); for abstract see *Ceram. Abs.*, **10** [8], 550 (1931). W.M.C.

Manufacture of rolled plate. XI. ERNST LUTZ. *Glass Ind.*, **12** [8], 166–71 (1931).—The lay-out of a grinding and polishing room and the store rooms for supplies is given in detail. Grinding apparatus with circular tables and continuously working grinding and polishing apparatus are described in detail. Illustrated. See also *Ceram. Abs.*, **10** [9], 634 (1931). E.J.V.

Résumé of a course in glassmaking. XI. ANON. *Rev. belge ind. verrières*, **2**, 83–86 (1931).—Opacifiers (phosphates, fluorides, stannic oxide, talc) are discussed. Details concerning the preparation of batch are given. Chapter IV takes up the matter of refractories for the glass industry and gives their properties. For Parts IX and X see *Ceram. Abs.*, **10** [9], 631 (1931). A.J.M.

Electric blowpipe for glassworking. KARSTEN. *Rev. belge ind. verrières*, **2**, 60–61 (1931). A.J.M.

Recent improvements in the manufacture of glass in America. ALEXANDER SILVERMAN. *Chim. & Ind.* [Special No.], pp. 567–78 (March, 1931).—Special physical and chemical properties, manufacturing control, and machinery are considered. (*C.A.*)

Amber glass for drugs. H. V. ARNY. *Nat. Glass Budget*, **47** [15], 12 (1931).—There are 400 light-sensitive medicines listed by American pharmacists. E.P.R.

All-glass vs. no-glass buildings. ALFRED E. FOUNTAIN, JR. *Ceram. Ind.*, **17** [2], 120–22 (1931).—F. discusses the question of all-glass buildings vs. buildings with no glass, citing several buildings of each type. He favors the all-glass type. See also *Ceram. Abs.*, **10** [4], 250 (1931). W.W.M.

Responsibility of manufacturer in selling containers. C. G. HICKS. *Ceram. Ind.*, **17** [2], 126–29 (1931).—H. cites several cases in which packers have ordered improperly designed glass containers for their appearance only, and on sterilizing in the retort the containers would break. He contends that the manufacturer should not allow customers to buy containers which are not designed with sufficient mechanical strength and correct practical shape. W.W.M.

Phototelescope for Naval Observatory. ANON. *Amer. Glass Rev.*, **50** [43], 28 (1931).—A new 40-in. photographic telescope designed to permit explorations covering 1500 million light years of space is being constructed for the Naval Observatory at Washington. New types of mirrors will help to improve the efficiency of the telescope. It is expected to have a photographic efficiency of 90% of its theoretical optical power, and should make possible more accurate measurements of millions of individual stars than ever before have been carried out. E.P.R.

New type of mirror. SCHROEDER PAINT & GLASS CO. *Nat. Glass Budget*, **47** [11], 3 (1931).—When the mirror is exposed to light the mirror part disappears and becomes a transparent piece of glass. E.P.R.

Modern lamp bulbs. F. W. PRESTON. *Glass Ind.*, **12** [8], 159–65 (1931).—The story of the development of lamp bulb-blowing machinery is briefly told. Detailed descriptions of the principles involved in the Corning bulb machine are presented and its operation is discussed. Illustrated. E.J.V.

Modern window-glass plant. ANON. *Amer. Glass Rev.*, **50** [44], 25–27 (1931); for abstract see *Ceram. Abs.*, **10** [5], 342 (1931). E.P.R.

Improvements at glass plant. ANON. *Ceram. Ind.*, **17** [2], 100–10 (1931).—Additions and improvements made at the plant of the Libbey Glass Mfg. Co., Toledo, Ohio, are described. Illustrated. W.W.M.

Glassmaking in Lorraine. E. G. CLARK. *Jour. Soc. Glass Tech.*, **15** [58], 107–19 (1931).—The craft was introduced toward the end of the 14th Century. The rights of a charter granted in 1469 to glassmakers are briefly set forth. The glasshouses increased from 4 to 7 by the middle of the 16th Century. A decline began in the next century and no trace was left of the glassworks in 1669. A brief summary is given of the glassmakers' families. G.R.S.

First factory to make glass wool in Britain. ANON. *Amer. Glass Rev.*, **50** [45], 12 (1931).—This factory has begun production in Glasgow, Scotland. E.P.R.

New Rotterdam department store. ANON. *Amer. Glass Rev.*, **50** [45], 28–29 (1931); for abstract see *Ceram. Abs.*, **10** [7], 509 (1931). E.P.R.

Discovery, history, and manufacture of glass and crystal ware. HELEN ROBERTSON. *Cleveland Plain Dealer*, **90,** No. 172 (1931).—Glassmaking in ancient Egypt as distinct from the glazing of pottery dates back to 1600 B.C. This brief history deals with Egyptian, Roman, and Venetian glass and the way in which the art was carried to England. The "Old Singing Waterford" glass, manufactured in Ireland toward the end of the 18th Century, is briefly discussed. The T. G. Hawkes & Co. was founded in Corning, N. Y., fifty years ago. Only decorating of glassware is done by this company. Its methods of decoration are described, as is the engraving process. The difference between true rock crystal and crystal glasses is pointed out. Illustrated. E.J.V.

History of drinking glasses. ARMAND BAAR. *Rev. belge ind. verrières*, **2,** 79–81 (1931).—Several illustrations are given with this historical account. A.J.M.

Georg Gehlhoff. H. RUKOP. *Z. tech. Physik*, **12** [7], 318–22 (1931); see also *Ceram. Abs.*, **10** [7], 494 (1931). W.M.C.

BOOKS

Glass. Vol. I. (Glas.) HERMANN THIENE. Published by G. Fischer, Jena, 1931. 363 pp. and 159 figs. Price 25 Rm. Reviewed in *Rev. belge. ind. verrières*, **2,** 88 (1931).—This volume discusses briefly raw materials, glass analyses, clays, furnaces, gas producers, gasification, heating and its control, melting, and devitrification. Lists of numerical data are included. The second part presents thermal, optical, mechanical, acoustical, magnetic, and electrical properties of glass. A second volume will be published. A.J.M.

Use of selenium in glassmaking. ANON. Published by E. Merck, Darmstadt,

Germany. 12 pp. Reviewed in *Rev. belge ind. verrières*, **2**, 64 (1931).—The uses and effects of selenium are discussed in this brochure. A.J.M.

PATENTS

Handling glassware. DANIEL B. WESTIN. U. S. 18,133, July 21, 1931 (reissue). Apparatus for removing glassware from molds comprising a vertically disposed guide, a member mounted for movement in the guide, a supporting arm and a guiding arm pivotally connected at their upper ends to the member on laterally offset axes, the arms forming a parallel-motion system, a ware-supporting device having pivotal connection with the lower ends of the arms, and a crank device rotatable about a fixed axis and pivotally connected to one of the arms between the ends thereof.

Producing openings, passages, etc., in molten or pressed-glass bodies. BERNHARD ERBER. U. S. 1,815,146, July 21, 1931. A method of producing openings, passages, capillaries, etc., in molten or pressed-glass bodies, comprising fusing into the glass material a composite wire consisting of a metallic core, a metallic coating, and a layer of graphite, talc, etc., between the core and the coating, the composite wire having about the diameter of the opening to be made and a coefficient of expansion higher than that of the glass, withdrawing the metallic core after cooling, and leaving the free opening in the glass.

Glass furnace. AUGUST KADOW. U. S. 1,815,258, July 21, 1931. The combination of a main furnace tank, a gathering pot, a conical distributor, and means for flowing a stream of glass from the tank onto the distributor and causing the glass to flow from the distributor into the gathering pot in sheet formation.

Drawing sheet glass. ROBERT L. CLAUSE. U. S. 1,815,288, July 21, 1931. In combination, in apparatus for forming sheet glass from a bath of molten glass, a metal guide member of heat-resisting metal extending horizontally in the bath with its upper edge adjacent the level of the surface of the bath, an anchoring tie extending downward from the member intermediate its ends for preventing the member from bowing up, and means for drawing a sheet continuously from the bath in line with the member.

Drawing sheet glass. WAYNE E. HARDING AND CECIL C. WEEKLEY. U. S. 1,815,473, July 21, 1931. In apparatus for the manufacture of sheet glass by drawing the glass upwardly from a bath of molten glass, the combination with a compartment containing the molten bath, a drawing block arranged in the compartment and having a drawing slot, means for drawing the sheet of glass upwardly through the slot, an agitator rotatably mounted in the glass bath beneath the slot and coextensive in length with the width of the sheet being drawn, and means for rotating the agitator.

Glass grinding. CLARENCE P. BYRNES. U. S. 1,815,547, July 21, 1931. The combination with a surfacing car or table mounted for movement along a track and having a glass-supporting surface, of a suction conduit leading from the table, means for applying the suction at a predetermined position of the table along the track, and abradant mechanism arranged to act upon a glass plate mounted on the car or table.

Producing sheet glass. JOSEPH A. REECE. U. S. 1,815,726, July 21, 1931. In sheet-glass apparatus, a tank containing a mass of molten glass and having an end wall, a member arranged within the wall and projecting rearwardly within the tank and having a slot therein beneath the level of the molten glass, a housing mounted in opposition to the member, a partition wall within the housing dividing the interior thereof into a heating chamber and a somewhat larger conditioning chamber, rotatable means within the conditioning chamber for receiving a stream of molten glass issuing from the slot and carrying it through the chamber in a generally horizontal direction, means for heating the heating chamber, and a pair of forming rolls for receiving the stream of molten glass and reducing it to a sheet of substantially predetermined and uniform thickness.

Glass. WILLIAM CHITTENDEN TAYLOR. U. S. 1,815,812, July 21, 1931. In a system carrying radio-frequency currents, the combination with a part charged with such currents, of an insulator therefor composed of a glass containing approximately 80% silica, 4% alkalis, and 13% boric oxide, the alkalis being lithia, soda, and potash.

Laminated glass. FRANK FRASER. U. S. 1,815,884, July 21, 1931. As a new article of manufacture, a sheet of laminated glass consisting of two or more sheets of glass with an interposed nonbrittle material and a solvent for inducing a bond between the glass and interposed nonbrittle material, the bond-inducing solvent having a high boiling point and low vapor pressure and being stable within the sheet, whereby in normal use the bond-inducing solvent will not materially accelerate the natural decomposition of the nonbrittle material and will not materially increase the normal tendency toward bubbling in the sheet.

Glassmelting preheater and mixer. GEORGE GLEN BROCKWAY. U. S. 1,815,890, July 28, 1931. In glass manufacture, the combination of a glassmelting furnace, a preheater for the glass-forming mixture, the preheater including a plurality of superposed hearths, means for causing the mixture to travel through the preheater in one direction, means for causing hot waste gases from the furnace to travel through the preheater and over the hearths in the opposite direction to preheat the mixture, and means for delivering such preheated mixture from the preheater to the furnace.

Glass-surfacing apparatus. JOHN H. FOX. U. S. 1,815,971, July 28, 1931. In combination in continuous sheet-surfacing apparatus, a track, a series of sheet-supporting cars mounted on the track for movement therealong, a series of surfacing machines arranged along the track provided with driven runners positioned above the sheets on the cars, a supporting framework carrying the track and the machines, a rigid foundation beneath the framework, and adjustable supporting devices intermediate the foundation and the framework arranged in series longitudinally and laterally thereof whereby any part of the framework may be adjusted vertically to bring the parts carried thereby into alignment.

Making plate glass. FREDERICK GELSTHARP. U. S. 1,815,972, July 28, 1931. In combination, a glass tank containing a body of molten glass and open above the bath adjacent the end wall of the tank, a pair of horizontal-driven sizing rolls arranged side by side with their center lines above the level of the glass, one of such rolls being located in the opening above the bath, and having its periphery contacting with the bath and the other of the rolls lying above the end wall of the tank, means for cooling the rolls so as to prevent the glass from sticking thereto, a glass-receiving bed or runway extending laterally at one side of the roll located above the end wall, means whereby the runway and rolls may be moved vertically as a unit, and means whereby the roll engaging the glass bath may be swung vertically around the axis of rotation of the other roll to regulate its degree of immersion in the bath.

Making glass. HARRY F. HITNER. U. S. 1,815,977 and 1,815,978, July 28, 1931. (1) In combination in apparatus for melting glass, a tank, a metal plate electrode constituting one of the walls thereof and exposed to the atmosphere on its rear face, a second electrode for transmitting current to the glass in the tank at a point remote from the plate, and means for supplying a current of electricity to the electrodes, the plate having its area of contact with the glass relatively large in proportion to its thickness. (2) In combination in apparatus for melting glass, a tank for melting the glass, metal electrodes extending into the tank, a foraminous, refractory, protecting means extending over the face of one of such electrodes and permitting contact of the molten glass in the tank with the electrode, and means for supplying current to the electrodes to secure a flow of current through the glass in the tank.

Making curved composite glass plates. JAMES H. SHERTS AND JOHN WILLITS.

U. S. 1,815,992, July 28, 1931. A process of making curved composite glass plates which consists in supporting two glass sheets which are to form the plate, one upon the other above a concave mold, applying heat sufficient to make the sheets plastic and causing them to sink into and fit the mold, but not sufficient to cause them to stick together, assembling the sheets as thus bent with an interposed sheet of flexible reinforcing material, and securing the sheets together.

Sheet-glass drawing apparatus. JAMES T. ZELLERS. U. S. 1,816,036 and 1,816,037, July 28, 1931. (1) In sheet-glass apparatus, a receptacle containing a mass of molten glass, means for forming a sheet therefrom, a tile arranged above the molten glass in spaced relation thereto, and members arranged at opposite ends of the tile and forming end closures for the space between the tile and the molten glass, the members having flues therein for conducting heat from beneath the tile. (2) In sheet-glass drawing apparatus, a receptacle containing a mass of molten glass, means for drawing a sheet therefrom, a lip tile arranged above the molten glass at one side of the sheet, the lip tile being composed of a plurality of sections positioned side by side with their adjacent edges abutting one another, each of the sections having a flue extending substantially horizontally therethrough, the forward ends of the flues being directed downwardly toward and terminating adjacent the surface of the molten glass, a common flue chamber with which the opposite ends of the flues communicate, a stack, and means placing the flue chamber in communication with the stack.

Sheet-glass drawing apparatus. JOSEPH P. CROWLEY. U. S. 1,816,040, July 28, 1931. In sheet-glass apparatus, a receptacle containing a mass of molten glass, means for drawing a sheet therefrom, a lip tile positioned above the molten glass at one side of the sheet and shaped to provide a recess therebeneath, the end of the tile nearest the base of the sheet terminating in a downwardly extending lip spaced from the end of the receptacle containing the molten glass, means for creating a current of heated gases beneath the receptacle and for directing the gases upwardly of the end of the receptacle and into the recess formed between the tile and the glass thereunder, a flue formed through the tile and communicating with the recess at the end thereof nearest the sheet being formed for withdrawing the heated gases from the recess, and means for controlling the withdrawal of the gases.

Bubbled colored glass articles. REUBEN HALEY. U. S. 1,816,045, July 28, 1931. The method of making a glass article which consists in gathering a core of molten glass, in causing finely divided bubble-forming material and finely divided colored glass to adhere thereto, in gathering an additional amount of molten glass over the core, and then blowing the combined gather to form the article, whereby the gases forming the bubbles will be generated at the same time that the pieces of colored glass are fusing into the mass.

Drawing sheet glass. JOHN L. DRAKE. U. S. 1,816,179, July 28, 1931. Method of forming sheet glass consisting in drawing a sheet of glass from a mass of molten glass, deflecting the sheet in one direction and reducing it to a substantially predetermined thickness, and then subsequently deflecting the sheet in the opposite direction.

Producing sheet glass. JOHN L. DRAKE AND LUKE C. MAMBOURG. U. S. 1,816,180, July 28, 1931. In sheet-glass apparatus, a receptacle containing a mass of molten glass, means for forming a sheet therefrom, means for heating the receptacle, a tile, and means for supporting the tile on the receptacle, the supporting means being of such character as to provide spaced openings through which heated gases may pass under the tile.

Fitter or shaper for glass articles. HALLER H. DAWSON AND IRA H. FREESE. U. S. 1,816,280, July 28, 1931. An apparatus including a holder for the article, a reciprocable member, a shaping head carried by the member, a plurality of pins each

having one end mounted in the head, a ring in which the opposite ends of the pins are mounted, shaping rollers mounted on the pins, and means for rotating the shaping head.

Roll for rolling glass plates from molten glass. LAMBERT VON REIS. U. S. 1,816,307, July 28, 1931. In a glass-forming roll comprising an inner core, a thin-walled outer shell tightly mounted on the core, and a single channel between the shell and core for the passage therethrough of a temperature-equalizing medium, the channel having the form of a double thread, adjacent ends of which are connected.

Delivery apparatus for molten glass. WILLIAM T. BARKER, JR. U. S. 1,816,309, July 28, 1931. Apparatus for delivering mold charges of molten glass from a glass feeder to a plurality of inclined troughs positioned adjacent to the feeder comprising a plurality of movably supported scoop blocks disposed adjacent to the feeder outlet and means for causing translatory movements of the respective scoop blocks in succession into and out of alignment with the feeder outlet and with the respective troughs.

Rolling raw plate glass. ERNST HILGERS. U. S. 1,816,374, July 28, 1931; Brit. 353,177, July 29, 1931. In a plate-glass rolling machine, in combination, a pair of cooperative forming rolls, a hopper above these rolls for receiving a mass of liquid glass, a glass-discharge slot in the hopper between the lower edges of the hopper side walls, coöperative preliminary forming rolls at the lower edges of the side walls delimiting the width of the discharge slot and regulating the thickness of the strip of glass discharged, plates for laterally closing the space between the preliminary forming rolls and the forming rolls, means for yieldingly pressing these plates with their upper and lower edges against the rolls to cause them to act as strippers, means for swinging the hopper side walls toward and away from each other about their lower edges, and means for adjusting the side walls with their lower edges and with the preliminary forming rolls relatively to each other for varying the thickness of the glass strip discharged between them and fed to the forming rolls.

Take-off and leering conveyer for sheet-glass forming machines. WILHELM SPIEKERMANN. U. S. 1,816,407, July 28, 1931. The combination with a leer conveyer, of an intermittent forming machine located above a portion thereof and a take-off mechanism receiving glass from the forming mechanism having reversible feed and in operative alignment with the conveyer.

Feeding molten glass. WILLIAM T. BARKER, JR. U. S. 1,816,463, July 28, 1931. Apparatus for feeding molten glass from a submerged outlet in a container and under the control of a reciprocating plunger, comprising a plurality of devices operating successively to move the plunger at different speeds during different portions of a single stroke, and means to permit independent adjustment of one of the devices relative to the other to vary the speed of the plunger movement produced by the device.

Glass-furnace forehearth. ALEXANDER FRANCIS MCNISH. U. S. 1,816,982, Aug. 4, 1931. The combination with a glass reservoir, of a horizontally arranged channel open at both ends to the reservoir, the channel being in the form of a return bend having divergent limbs, one limb of which extends out from the wall of the reservoir at right angles thereto, while the other limb returns the glass to the reservoir in a direction away from the glass entering the channel, a gathering portion formed by a substantially semicircular bend in the channel at the part furthest removed from the reservoir, and a cover over the channel having apertures to receive gathering and circulating devices.

Mold for glass cylinders. WILLIAM G. TWYMAN. U. S. 1,817,046, Aug. 4, 1931. A mold comprising a pair of semicylindrical sections hingedly joined together and a removable base plate carried adjacent its outer edge by the sections and spaced apart therefrom.

Making sheet glass. MYRON L. BEGEMAN. U. S. 1,817,055, Aug. 4, 1931. In apparatus for making sheet glass, in combination, a pair of horizontal forming rolls side by side, means for feeding molten metal onto the upper surfaces of the rolls, an adjustable nonrotatable member adjacent each of the rolls whereby as the rolls rotate a sheet of metal is formed on each roll, the continued rotation of the rolls acting to carry the sheets between the rolls thereby uniting the two sheets into a finished sheet of desired thickness.

Glass-washing machine. ARTHUR G. WORRALL. U. S. 1,817,332, Aug. 4, 1931. A machine for washing glass and articles in sheet form, comprising a plurality of pairs of feed rolls of yielding material between which the glass may be successively fed forward while being subjected to the yielding pressure of the rolls, a pair of brushes arranged between each two adjacent pairs of feed rolls, one of the brushes of each pair operating upon one surface of the glass and the other operating upon the other surface of the glass, means for feeding jets of separate bodies of fluid to the respective pairs of brushes, means for rotating the feed rolls at a low surface speed, means for rotating the brushes at a relatively high speed, means for recirculating the separate bodies of fluid to their respective brushes and glass sheet, a supporting frame for the brushes and fluid-feeding means, and wherein further, the respective pairs of brushes are arranged in separate compartments and the means for supplying heated fluid to the brushes are arranged to discharge into the respective compartments for the pairs of brushes, and means for heating the fluid are provided to insure the fluids of each compartment being maintained at different temperatures whereby the glass is successively treated to fluids of increasing temperature.

Inside coating bulbs. KEIJI TSUYUKI. U. S. 1,817,783, Aug. 4, 1931. The method of temporarily coating a portion of the inside surface of a hollow-glass article having one opening which consists in submerging the opening of the article to a predetermined depth in a static pool of molten liquid coating material, venting the article through the opening to permit the molten material to rise in the article and thereby wet a predetermined portion of its inner surface, cooling the article to convert the adherent material on the wetted surface into a solid protective coating, and subsequently removing the coating.

Making goblets, etc. WILSON EARL KEE. U. S. 1,817,826, Aug. 4, 1931. The herein-described method of making a goblet consisting in laterally enlarging a portion of a glass tube to provide a bowl and stem, in heating an annular portion of the stem near the bowl, in subjecting such portion to an inward pressure through the medium of the flame directed thereagainst at an angle to its axis and inclined in the direction of the bowl, in subjecting such portion to a transverse strain acting in the direction of the axis of the stem and away from the bowl, to separate the stem from the bowl and provide walls closing the bowl and stem, in melting out the wall of the bowl through the medium of the flame, in fusing the stem and its wall to the bowl, and in flanging the stem outwardly to provide a base.

Bottle. JACOB W. BEHRENDT. U. S. 1,817,912, Aug. 11, 1931. A bottle having a pouring neck and an outwardly directed pouring lip around its upper end, threads around the neck at a point spaced below the pouring lip, a relatively long unthreaded portion between the lip and the threads, the unthreaded portion being curved inwardly to smaller diameter to form a balancing neck.

Making glass sheets. HOWARD L. HALBACH. U. S. 1,818,130, Aug. 11, 1931. In combination with apparatus arranged to draw a glass sheet from a pool of molten glass, means for chilling the glass below the line of generation of the sheet comprising a fluid-cooled pipe extending across the bath beneath the line of generation of the sheet, and edge-holding means comprising a pair of upwardly extending members carried by

the pipe and terminating at the points where the edges of the sheet are drawn from the molten body.

Forming sheet glass. WILLIAM E. NOBBE. U. S. 1,818,152 and 1,818,153, Aug. 11, 1931. (1) In sheet-glass forming apparatus, the combination with a furnace containing a mass of molten glass and provided with an outlet through which a stream of molten glass issues, of means for directing the stream in a substantially horizontal path and reducing the same through successive stages to sheet form, including a plurality of pairs of sheet-forming rolls, the rolls being constructed to reduce the thickness of the stream first at its center and to then subsequently reduce the end portions to the same thickness, and means for supporting the stream of glass between adjacent pairs of forming rolls to prevent sagging of the thinner portions of the stream with respect to the thicker portions thereof. (2) In apparatus for forming sheet glass, the combination with means containing a source of molten glass and from which a single molten stream is adapted to flow, of a forming slab positioned adjacent the means and having a trough in its upper end for receiving the stream therefrom, the slab being also provided with substantially vertical downwardly diverging side faces whereby the glass within the trough will overflow therefrom in two individual streams down the diverging side faces of the slab, and a plurality of rotatable members mounted opposite each face of the slab and coöperating therewith for gradually reducing the stream through successive stages to a sheet of substantially predetermined thickness, the uppermost member tapering from its center toward its opposite ends and the succeeding lower members gradually approaching cylindrical form, each side face of the slab being bowed transversely with varying degrees of curvature from top to bottom thereof, so that the cross-section curvature of the face of the slab substantially inversely coincides with the longitudinal contour of the opposed rotatable members.

Manufacture of sheet or plate glass. WILLIAM E. NOBBE. U. S. 1,818,154, Aug. 11, 1931. In apparatus, a table for receiving and supporting a newly formed sheet of glass thereupon, the table comprising a bottom, a stationary bed freely supported upon the bottom and having a plurality of spaced parallel transversely extending recesses in its upper surface, rotatable rolls disposed within the recesses, means for driving the rolls in unison, means carried by the bottom and engaging the undersurface of the bed for raising and lowering the same with respect to the rolls, and means also carried by the bottom and engaging the bed for guiding the bed in its vertical movements and for preventing lateral movement thereof.

Laminated glass. JAMES W. H. RANDALL. U. S. 1,818,159, Aug. 11, 1931. A device for sealing laminated glass comprising a temperature control receptacle for containing the sealing material, an outlet therefor, and a heated wire onto which the sealing material flows.

Means for treating glass apparatus. HERBERT THOMAS. U. S. 1,818,175, Aug. 11, 1931. The combination with a circulatory glass-supporting table, of means for applying a protective medium thereto including a holder arranged transversely of the table, a shaft carrying the holder, arms within which the opposite ends of the shaft are journaled, the arms being pivoted intermediate their ends, protective medium-applying means carried by the holder, counterweights carried at the outer ends of the arms to hold the last-named means in engagement with the table, a worm gear keyed to the shaft, and a worm screw mounted upon one of the arms and meshing with the gear and adapted upon rotation thereof to effect adjustment of the holder about the axis of the shaft to bring new protective medium-applying surfaces into contact with the table.

Producing sheet glass. CARROLL CONE. U. S. 1,818,195, Aug. 11, 1931. (1) The process of producing sheet glass, which consists in first forming the sheet, carrying the sheet forwardly as it is formed in a generally horizontal direction and to a predetermined

location, turning the sheet upside down, and then passing the sheet forwardly into and through an annealing zone. (2) In sheet glass apparatus, means for receiving a newly formed sheet of glass from sheet-forming mechanism and delivering it into an annealing leer including conveying means for receiving the sheet thereupon from the sheet-forming mechanism, a second conveying means for delivering the sheet into the annealing leer, and means for rotating the first conveying means to turn the sheet upside down and bring it to rest upon the second conveying means.

Annealing leer. JOHN L. DRAKE. U. S. 1,818,201, Aug. 11, 1931. In sheet-glass apparatus, an annealing leer, means for passing a sheet of glass therethrough, and a plurality of heat-absorbing members arranged in the leer and on both sides of the sheet, the members being mounted progressively closer to the sheet as the exit end of the leer is approached.

Producing sheet glass. JOHN L. DRAKE. U. S. 1,818,202, Aug. 11, 1931. A continuous tank furnace including a melting chamber, a refining chamber adjoining and in direct communication with the melting chamber, a cooling chamber adjoining and in direct communication with the refining chamber, a working receptacle adjoining and in direct communication with the cooling chamber, all of the chambers together with the working receptacle containing molten glass and being of the same width throughout, and heating means within the melting chamber for directing a flame upon the surface of the molten glass therein.

Producing molten glass. JOHN L. DRAKE. U. S. 1,818,203, Aug. 11, 1931. In a continuous tank furnace, a melting tank containing a mass of molten glass, a cooling chamber in communication with the melting tank, means for causing the lowermost stratum of molten glass within the melting tank to flow through the cooling chamber, and means for causing the uppermost stratum or surface glass to flow exteriorly of the melting tank.

Forming sheet glass. JOHN L. DRAKE. U. S. 1,818,204, Aug. 11, 1931. In the process of forming sheet glass, those steps which consist in depositing a mass of molten glass upon a movable support and moving the support to bring the molten glass under a plurality of forming rolls to subject the same to a series of successive rolling operations wherein the glass is reduced first at its center and the end portions, then subsequently reduced gradually through successive stages to the same thickness to form a sheet of substantially predetermined thickness and width.

Sheet-glass drawing apparatus. JOHN L. DRAKE. U. S. 1,818,205, Aug. 11, 1931. In sheet-glass drawing apparatus, a receptacle containing a mass of molten glass, a member coöperating with the receptacle for segregating a pool of molten glass from the mass, means for drawing a sheet upwardly from the pool, and lip tile positioned above the receptacle at opposite sides of the sheet, the lower end of one lip tile resting upon the receptacle and the lower end of the other lip tile resting upon the member coöperating therewith.

Production of plate-glass blanks. JOHN L. DRAKE. U. S. 1,818,206, Aug. 11, 1931. Process of producing sheet-glass or plate-glass blanks, consisting in first melting and refining molten glass in a portable pot, in teeming the molten glass from the pot into a stationary receptacle by moving the pot from one end of the receptacle to the other during the pouring of the molten glass thereinto, tilting the receptacle to cause the molten glass to flow therefrom in a relatively wide stream onto a table, and in reducing the stream of glass to sheet form as it is received upon the table.

Forming sheet glass. JOHN L. DRAKE. U. S. 1,818,207, Aug. 11, 1931. In apparatus for the manufacture of sheet glass, a furnace having an outlet through which is adapted to flow a relatively thick, narrow stream of molten glass, a table for receiving the stream of glass from the furnace and causing a widening thereof, a roll for receiving

the thus widened stream from the table, the roll tapering from its center toward its opposite ends, and a pair of forming rolls for receiving the stream from the first roll and reducing it to a sheet of substantially predetermined dimensions.

Forming and annealing sheet glass. JOHN L. DRAKE. U. S. 1,818,208, Aug. 11, 1931. In apparatus for the production of sheet glass, means for forming the sheet, an annealing leer, a truck, an endless conveyer carried by the truck and arranged transversely thereof, means for moving the truck and conveyer forwardly as a unit during the laying of the sheet thereupon for carrying the sheet to a position adjacent the anneal ing leer, and separate means for driving the conveyer in a direction at right angles to its first direction of movement to deliver the sheet therefrom into the annealing leer.

Producing sheet glass. JOHN L. DRAKE. U. S. 1,818,209, Aug. 11, 1931. A system for producing sheet glass, comprising a track, annealing leers arranged on each side of the track, a plurality of conveyer means adapted to be reciprocated upon the track, a sheet-forming mechanism positioned over the track and adapted to deposit the sheet formed on the conveyer as it moves therebeneath, the sheet being produced at a relatively high rate of speed, the sheet also being divided into sections, each of the conveyer means being provided with transversely movable means, and means for operating the transversely movable means both to the right and left whereby the sheets can be transferred to the leers on either side of the track as desired.

Sheet-glass apparatus. LEOPOLD MAMBOURG. U. S. 1,818,231, Aug. 11, 1931. In sheet-glass apparatus, a tank furnace containing a mass of molten glass, a draw pot communicating therewith for receiving the molten glass therefrom and having a closed outer end, a lip tile disposed above the molten glass and having its front end supported on the closed end of the draw pot, means for supporting the outer end of the lip tile and coöperating with the lip tile to form a tunnel therebeneath, a heating chamber disposed beneath the draw pot and in communication with the tunnel, means for heating the chamber, a stack also in communication with the tunnel for drawing the exhaust gases therefrom, and temperature-control means positioned beneath the lip tile and partially immersed within the molten glass.

Sheet-forming mechanism. LEOPOLD MAMBOURG. U. S. 1,818,232, Aug. 11, 1931. In sheet-glass apparatus, a receptacle containing a mass of molten glass, means for causing a flow of glass to pass therefrom under the head pressure of the glass in the receptacle, and a pair of substantially parallel curved members for reducing the flow to sheet form.

Laminated glass. WILLARD C. MCDANIEL. U. S. 1,818,235, Aug. 11, 1931. The process of producing laminated glass, consisting in forming a sandwich from the laminations to be joined, arranging a compressible member on each side of the sandwich, applying "stickers" at the edges of the sandwich and compressible members to prevent slippage between the laminations, and then applying pressure to the assembly thus formed to obtain a bond between the laminations.

Laminated glass. WILBUR F. BROWN. U. S. 1,818,458, Aug. 11, 1931. The process of producing laminated glass consisting in humidifying a sheet of nonbrittle material, then interposing the humidified sheet between two glass sheets, and uniting the same.

Glassblowing machine. EDWARD H. LORENZ. U. S. 1,818,725, Aug. 11, 1931. In a glassblowing machine, the combination of a turret carrying a mold, means for intermittently rotating the turret, a blowhead mounted on the turret to coöperate with the mold, a valve controlling the application of pressure by the blowhead to the mold, and automatic means effective to actuate the valve, the last-named means being operable independently of the rotative periods of the turret.

Feeding molten glass. BRITISH HARTFORD-FAIRMONT SYNDICATE, LTD. Brit. 352,195, July 15, 1931.

Rolling glass. Y. BRANCART. Brit. 352,346, July 15, 1931.

Tempering glass. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE ST.-GOBAIN, CHAUNY, ET CIREY. Brit. 352,359, July 15, 1931; see also *Ceram. Abs.*, **10** [8], 564 (1931).

Manufacture of silica articles. BRITISH THOMSON-HOUSTON CO., LTD. Brit. 352,375, July 15, 1931.

Leers for annealing glassware. BRITISH HARTFORD-FAIRMONT SYNDICATE, LTD. Brit. 353,245, July 29, 1931.

Grinding or lapping gears. DETROIT & SECURITY TRUST CO. Brit. 353,675, Aug. 6, 1931.

Manufacture of glass articles. MACBETH-EVANS GLASS CO. Brit. 353,770, Aug. 6, 1931.

Laminated glass. WM. H. MOSS. Can. 311,770, May 26, 1931. Laminated glass is prepared by interposing between adhesive-coated sheets of glass a sheet of plastic composition containing cellulose acetate and dibutyl tartrate as plasticizer and pressing at suitable temperature. (*C.A.*)

Composite glass. LIBBEY-OWENS-FORD GLASS CO. Fr. 699,586, July 9, 1930. Composite glass is made by coating 2 sheets of glass with a solution of gelatin in glycerol or other solvent other than water, placing an unbreakable membrane such as plastic pyroxylin between the 2 coated surfaces, and pressing the whole together and heating. (*C.A.*)

Glassmaking furnaces. ENTERPRISE GÉNÉRALE DE CHAUFFAGE INDUSTRIEL. Fr. 701,130, Aug. 4, 1930. Means for heating the furnaces to a high temperature with liquid fuels are described. (*C.A.*)

Continuous production of sheet glass. E. DANNER. Ger. 508,987, Feb. 15, 1920. In producing continuously a sheet of glass by allowing a stream of molten glass to flow over a distributor member of width greater than that required in the sheet being drawn off from the lower end of the member, means are provided for controlling the cooling of the glass as it passes over the surface of the distributor in order to control the width and thickness of the sheet produced. Alternatively, the glass can flow on each side of the distributor and unite at the bottom to form the sheet. (See also *Ceram. Abs.*, **9** [1], 29 (1930)). (*J.S.G.T.*)

Drawing glass tube and cane. GLASFABRIK WEISWASSER G.M.B.H. Ger. 512,949, Nov. 2, 1921. In drawing tube or cane as by the Danner method, no special nose is fitted to the rotating mandrel but the glass is drawn off from the inner surface of the lower end of the mandrel. (*J.S.G.T.*)

Enameling and annealing furnaces. WILLI KRAZE & CO. G.M.B.H. Ger. 520,836, Aug. 10, 1926. Details of charging are given. (*C.A.*)

Rolling plate glass. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE ST.-GOBAIN, CHAUNY, ET CIREY. Ger. 522,501, Feb. 29, 1928. (*C.A.*)

Rolling endless glass bands from the molten glass. MONTAN- UND INDUSTRIALWERKE VORMALS JOHN D. STARCK. Ger. 522,816, Jan. 18, 1929. (*C.A.*)

Drawing an endless glass band. RENÉ ARCQ. Ger. 524,285, Feb. 26, 1930. (*C.A.*)

Structural Clay Products

Observations on the firing of a downdraft kiln with a stoker situated outside thereof. W. E. RICE AND H. C. HARRISON. *Jour. Amer. Ceram. Soc.*, **14** [9], 643–57 (1931).

Handling air. R. R. ROBINSON. *Jour. Amer. Ceram. Soc.*, **14** [9], 658–68 (1931).

Power consumption in clay-plant operation. J. OTIS EVERHART. *Jour. Amer. Ceram. Soc.*, **14** [9], 669–74 (1931); see also *Ceram. Abs.*, **10** [5], 367 (1931).

A tile designed to effect a scientifically built wall. A. W. KEICHLINE. *Bull. Amer. Ceram. Soc.*, **10** [9], 287–92 (1931).

New type of ceramic structural material. W. E. BUDGE. *Bull. Amer. Ceram. Soc.*, **10** [9], 293–94 (1931).

Lead-mine chats utilized in manufacture of brick. ANON. *Pit & Quarry*, **22** [9], 15 (1931).—The Komnick Process Brick Co. has been formed at Festus, Mo., for the manufacture of clayless brick. Ground chats obtained from the lead and zinc mines in that region will be the chief raw material employed, together with silica of sand and lime. E.P.R.

Volume changes in brick masonry materials. L. A. PALMER. Bur. Stand., *Jour. Research*, **6** [6], 1003–26 (1931); R.P. 321; *Rock Prod.*, **34** [15], 44–51 (1931); see also *Ceram. Abs.*, **10** [9], 640 (1931). R.A.H.

Chemical investigation of moist brick masonry. GERHARDT SCHMIDT. *Chem.-Ztg.*, **58,** 558–59 (1931).—The masonry of a 15-year old house was examined. Water contents of powdered-brick samples were found to range from 0.84 to 7.21%. The dried samples absorbed 1.11 to 18.93% water on standing for 10 days in direct contact with distilled water in a desiccator, but were able to dry in the air, giving off the excess water. In water extracts Cl was found in amounts from 0.08 to 0.46%, CaO 0.13% to 0.72, N_2O_5 0.21 to 0.51, and MgO 0.01 to 0.08. The origin of moisture in the brick is explained partly by the situation of the house near a swamp and partly by the fact that the brick are hygroscopic. The soluble salts are nitrates and chlorides, but only the latter are responsible for water absorption. As some brick used for the structure came from an old stable, the nitrates are a product of ammonia by action of bacteria. J.G.T.

Brickote for walls. ANON. *Bldg. Supply News*, **41** [1], 14 (1931); for abstract see *Ceram. Abs.*, **10** [9], 641 (1931). E.C.C.

Competition of building materials. E. J. SIEDLER. *Tonind.-Ztg.*, **55** [59], 855–58 (1931).—This paper deals with the possibility of using different building materials for houses, etc. S. concludes that fired building materials are of great value now and should defeat all other substitutes. W.M.C.

Handling and storage of brick. THOMAS J. KANE. *Brick Clay Rec.*, **79** [1], 22–23 (1931).—Some of the specific hazards in handling and storage of brick which are peculiar to all brick plants in varying degrees are enumerated and methods of eliminating them are suggested. E.J.V.

Rattler test for paving brick considered as efficacious method for establishing the permissible limit of absorption. E. ORTON, JR. *Proc. A.S.T.M.*, **5,** 287 (1905); *Rev. mat. constr. trav. pub.*, No. 257, pp. 36–38*B* (1931). M.Y.H.

Designers of clay products. C. E. LOVEWELL. *Brick Clay Rec.*, **79** [1], 16–20 (1931).—Although it would be well for the clay-products industry to employ designers, it would hardly be possible to employ outstanding architects who have been responsible for the color range and design of brickwork in the modern buildings. The work of some of these men is discussed and illustrated. E.J.V.

Brick building in northern Germany. J. GRELL. *Tonind.-Ztg.*, **55** [54], 777–82 (1931).—Brick building has been developed to a high standard in northern Germany. Old and modern buildings are illustrated. W.M.C.

Technical development of the German brick industry. A. HIELSCHER. *Tonind.-Ztg.*, **55** [54], 782–89 (1931).—The old way of making brick, especially the furnace, is mentioned. The development of brickmaking is traced and some means of mechanization used in modern plants of high capacity are shown. W.M.C.

Brick industry. GRAWINCKEL. *Tonind.-Ztg.*, **55** [54], 789–92 (1931).—The importance of the brick industry, etc., in earlier times and today is outlined. W.M.C.

Brick buildings of former centuries. ANON. *Tonind.-Ztg.*, **55** [56], 818–19 (1931).—Some ancient brick buildings at Luebeck, Germany, are described. Illustrated. W.M.C.

Brick road. F. WATTEBLED AND F. CARINI. *Rev. mat. constr. trav. pub.*, No. 260, pp. 91–93*B* (1931).—Researches on tests for paving brick were begun in the U.S. in 1885. The tests practiced from that time are given in detail. See also *Ceram. Abs.*, **10** [8], 570 (1931). M.Y.H.

Sand-lime plant Niedersachsen. B. KRIEGER. *Tonind.-Ztg.*, **55** [50], 721–22 (1931).—The building of the new sand-lime plant Niedersachsen, in Germany, was initiated by several contractors, thus securing the constant sale of the products. The installations and machines of the plant are outlined and photos are given. See also *Ceram. Abs.*, **10** [2], 119 (1931). W.M.C.

Russian building materials industry. ANON. *Tonind.-Ztg.*, **55** [57], 834–35 (1931).—A considerable shortage of building materials prevails in Russia. Several new plants have been erected and more are planned. W.M.C.

Brick from antiquity to the present. KAHR. *Tonind.-Ztg.*, **55** [58], 842–45; [59], 861–62 (1931).—The advantages of brick in comparison with other building materials are outlined. W.M.C.

Sir Marc Isambard Brunel. JUDSON VOGDES. *Clay-Worker*, **96** [1], 29–31 (1931).—A brief biographical sketch of Brunel is presented. Throughout the life of this engineer, brick masonry played a conspicuous part in making possible the great engineering projects for which he is famous. He built one of the most spectacular brick masonry structures of all time and also conceived the principle of combining masonry and metallic reinforcing, now known as reinforced brick masonry, over one hundred years ago. Illustrated. E.J.V.

Architecture of high school. ANON. *Arch. & Bldg.*, **58** [4], 84–85 (1931).—The Sewanhaka Central High School, Floral Park, N. Y., is three stories in height. The exterior design is an adaptation of Georgian architecture executed in Harvard brickwork with stone-ashlar base, quoins, trim, and central motif. E.P.R.

Aetna Life Insurance Co.'s new building. ANON. *Arch. & Bldg.*, **58** [4], 80–82 (1931).—This building has been described as the largest building of Colonial design in the world. It represents an adaptation of the early Connecticut style of architecture to the requirements of a modern office building. The structure, which is eight stories tall, is built for the most part of Connecticut red brick and brownstone. E.P.R.

Effective treatment of brick. ANON. *Brick Clay Rec.*, **79** [2], 74–75 (1931).—Photographs of a New York office building, a Chicago apartment house, and a Springfield, Ill., bakery are presented to illustrate some striking effects that were obtained by the use of brick in unusual joints and arrangements. E.J.V.

Steel house with clay products in its walls. ANON. *Brick Clay Rec.*, **79** [2], 61–62 (1931).—A brick and tile hollow enclosure wall 9 in. thick, providing perfect insulation, is being used in the construction of the welded steel house in Shaker Heights, Cleveland. Details of the construction are given. Illustrated. E.J.V.

Kohler Village is built of brick. ANON. *Clay-Worker*, **96** [1], 18–21 (1931).—Kohler Village, a town-planned industrial community in eastern Wisconsin, where 75% of the homes are all or part brick, is described. Illustrated. E.J.V.

Model brick home. LAURENCE SMITH. *Brick Clay Rec.*, **79** [1], 34–36 (1931).—In its construction of the model brick home in which 163,000 common brick were used, T. K. Windham, Inc., of Atlanta, Ga., has extended the use of brick in the project to embrace not only walls and foundations, but interior partitions, reinforced brick driveway, basement, porch floors, and walks. Construction details are given. Illustrated. E.J.V.

PATENTS

Stairway step. CHARLES L. WOOLDRIDGE. U. S. 1,815,126, July 21, 1931. A block for use in stairway construction, the block being of relatively small width to permit a number to be assembled to constitute a step, being of a length greater than the desired width of the stairway tread, and being formed with a recess in one face adjacent one end and with a second recess in the opposite face adjacent the opposite end, whereby the recess at one end of a block will register with the recess at the other end of a block of the next succeeding step, to receive a binding substance.

Clay-texturing machine. EDWARD G. FINZER AND CHARLES S. FINZER. U. S. 1,815,469, July 21, 1931. A machine for texturing surfaces of a moving clay column, etc., including a plurality of rotary cutters each adapted to rotate against a surface of a moving clay column, a single drive shaft, a driving connection between each of the cutters and the drive shaft, and oscillating arm means driven by the same drive shaft for clearing away the clay particles removed from the clay column by the cutters.

Brick and tile machine. ALEXIS PRESTON STEELE. U. S. 1,815,809 and 1,815,810, July 21, 1931. (1) In combination with the shaft of a straight-line combined brick and tile machine common to both the tub and barrel, a driving means, a flexible connection between the driving means and an end portion of the shaft, and supporting means engageable from below with the shaft between the pugging portion and the expressing portion of the shaft. (2) In combination with a shaft of a brick and tile machine, a rim surrounding the shaft and disposed intermediate the ends thereof, spokes operatively connecting the rim and the shaft, the spokes constituting knives, and supporting means rotatably engaging the rim.

Building wall of cellular blocks. KEMPER SLIDELL AND EDWIN M. WYATT. U. S. 1,817,022, Aug. 4, 1931. A wall composed of a plurality of blocks of cellular argillaceous material, the cell walls of each block being of vitrified material and the cells being individually formed and noncommunicating, the superposed surfaces of adjacent blocks being planate and exposing pockets formed by cutting through the cells, and the blocks being bonded by cementitious material filled into the exposed pockets, whereby portions of the adjacent planate surfaces of the blocks may be in substantial contact.

Extruding a bloated clay product. KEMPER SLIDELL. U. S. 1,818,101, Aug. 11, 1931. The method of producing cellular material which consists in feeding granular earthy material into a heat zone maintained at a bloating temperature, and in confining the material while in granular form and while in the heat zone in order to effect fusion and bloating of the material while subjected to confinement, the bloated material being extruded from the zone of confinement under pressure due to expansion of the material.

Brick-handling mechanism. ARLINGTON H. MALLERY AND ERNEST M. HICKS. U. S. 1,818,728, Aug. 11, 1931. A brick-handling mechanism comprising in combination a frame, devices for supporting the brick pivotally mounted on the frame, vertically extending supporting bars pivotally connected at their lower ends with the devices between the pivots of the devices and the free ends thereof for supporting the devices, and an abutment plate for preventing the brick from passing between the bars.

Brick-laying machine. THOMAS PALATINI. U. S. 1,818,741, Aug. 11, 1931. A brick-laying machine including a scaffold, means for supporting a plurality of layers of brick temporarily on the scaffold, means for moving the brick one layer at a time to a given point, mechanism for causing the brick to be placed on top of a wall which is being built after the moving means have moved the brick to the given point, means for intermittently raising the scaffold, and means for intermittently raising the brick in the box, the last-mentioned means functioning simultaneously with but independently of the means for raising the scaffold.

Manufacture of hollow brick. L. AVANZINI. Brit. 352,149, July 15, 1931.

Refractories

Studies of clay mixtures for glassmelting pots. III. Flow at high temperatures of pot-clay refractories under stress. J. H. PARTRIDGE AND G. F. ADAMS. *Jour. Soc. Glass Tech.*, **15** [58], 190–208 (1931).—Rapid tensile tests are likely to give misleading results. Creep tests are more applicable to the pot problem. The aluminous clay gave higher values than the siliceous for the temperature of failure with the tensile test, but prolonged creep test showed that the siliceous clay would withstand the more severe conditions of stress and temperature. The aluminous clay seemed to flow continuously when under stress at temperatures as low as 1300°, but the siliceous clay attained constant dimensions under similar conditions. Conditions of stress and temperature are more definite in the case of the siliceous clay and if these conditions become more exacting, failure will be rapid. Failure is more gradual in the case of aluminous clay, which is preceded by considerable plastic flow. Presence of grog decreases the strength of fireclay refractory materials at high temperatures and the amount of grog should be a minimum governed only by conditions of drying and ability to resist thermal shock. Coarse grog reduces the strength. The higher temperature of failure of the aluminous clay may be of use in resisting high temperatures for short periods of time. The tendency of pots to split down the back or to squat can be minimized by (1) reducing the content of grog, (2) changing the grading of the grog, and (3) reducing the ratio of the pot diameter to wall thickness. For Parts I and II see *Ceram. Abs.*, **10** [8], 573 (1931); see also *Ceram. Abs.*, **10** [9], 645 (1931). G.R.S.

Development, properties, and technical use of some spinels. R. RIEKE AND K. BLICKE. *Ber. deut. keram. Ges.*, **12** [4], 163 (1931).—Magnesia spinel, $MgO{\cdot}Al_2O_3$, has a melting point at 2030°C and is in the MgO–Al_2O_3 diagram at a maximum. Mixtures of MgO and Al_2O_3 and $MgCO_3$ and Al_2O_3 were used in molecular proportions adding some mineralizers, *e.g.*, boric acid, tungsten acid, and chromium oxide. The shaping was difficult as only after calcining at 920° were samples easy to handle. The firing was done in a porcelain kiln at Seger cone 16 for 24 hr. Some samples were fired a second time at Seger cone 33. The formation of spinel was determined by dissolving in HCl that part of the MgO that did not react during the firing process. The spinel formation appeared completed at cone 16 and there was no further development at cone 33. These data were checked by X-ray and optical examinations and determination of specific weight was made. As the strength of the samples was poor and porosity was high, several additions were used and their influence on refractoriness was tested. An attempt was made to lower the porisity by grinding and reshaping the fired samples and by adding boric acid which was the most effective mineralizer. This was not successful, however. Additions up to 3% CaO and 5% SiO_2 lowered the refractoriness only to 1800 to 1900°. The porosity could be lowered successfully by grinding the raw materials in a porcelain ball mill for about 6 hr. Spinel cylinders and crucibles were manufactured out of technically pure raw materials (magnesite from Frankenstein and alumina) by grinding in a porcelain ball mill for 6 hr. with 3% boric acid and drying. Small balls were shaped from this prepared mixture and fired in a porcelain kiln. These were ground again (0.25 mm.) and shaped by pressing. Such crucibles could be heated several times to 1800° without deformation. Deformation occurred at 1900°. Tests for spalling proved that up to 850° no cracks occurred, from 1200 up the crucible failed badly, and at 1050° the strength was weakened. Resistance against load at higher temperatures is not higher in spinel bodies than in any good grog brick. The softening interval is larger. The coefficient of expansion was determined for temperatures between 25 to 800° and it was found that it increased with the higher temperature. Other mixtures, especially ZnO and Al_2O_3, were tested in different proportions. I.R.

Special refractories for use at high temperature. WM. H. SWANGER AND FRANK

R. CALDWELL. Bur. Stand., *Jour. Research*, **6** [6], 1131–43 (1931); R. P. 327; summarized in Bur. Stand, *Tech. News Bull.*, No. 170, pp. 64–65 (1931).—The choice of the most suitable refractory for the laboratory melting of pure metals at temperatures from 1700 up to 2200 °C without detrimental contamination of the metal by the refractory depends on a number of factors, *e.g.*, the stability of the refractory at the higher temperatures, the means available for forming and firing of crucibles, the type of melting furnace, chemical action of the particular metal in question, etc. Methods are described in detail for the preparation of crucibles and other shapes from the oxides of thorium, magnesium, zirconium, and beryllium. Thorium oxide with a melting point about 3000 °C, is the most refractory of the four oxides named. The method used for fusing this oxide is described. Crucibles made of fused thorium oxide have been used in the determination of the melting points of platinum and rhodium. Crucibles of the commercial fused magnesium oxide are not satisfactory for work with metals of the highest purity, but crucibles prepared from the so-called "C.P." or reagent grade of powdered magnesium oxide have been used at temperatures up to 2000 °C without detrimental effect on the metal melted. The commercial electrically-fused or sintered zirconium oxide contains small amounts of silica. Crucibles of this material have been used at temperatures up to 2000 °C, but unless the melting is done in air, there is danger of contamination of the metal by the silicon in the refractory. Indications from few experiments made, are that beryllium oxide might be a satisfactory refractory for use at high temperatures.

R.A.H.

Gas permeability of refractories at high temperatures. H. IMMKE AND W. MIEHR. *Refrac. Jour.*, **7** [7], 364 (1931); for abstract see *Ceram. Abs.*, **10** [5], 355 (1931).

E.P.R.

Dilatometric study of some refractory oxides. F. GAMBEY AND G. CHAUDRON. *Chim. & Ind.* [Special No.], pp. 453–54 (March, 1931).—The MgO crucibles previously described have the drawback of a high-expansion coefficient. Expansion curves for a number of other refractories were determined up to 1600° by means of a Chevenard recording dilatometer and showed that quite a number of other oxides, *e.g.*, BeO, ZrO_2, Al_2O_3, Cr_2O_3, and ThO_2, had much lower expansion coefficients than MgO; moreover, certain combinations, *e.g.*, MgO–Al_2O_3 and MgO–ZrO_2 have relatively small expansion coefficients, high melting points, and better mechanical properties at high temperatures than MgO. See also *Chem. Abs.*, **22**, 4384. (*C.A.*)

Symposium on "Variation in size of fire brick." ANON. *Jour. Amer. Ceram. Soc.*, **14** [9], 675–99 (1931).—This symposium contains the following articles: (*a*) "Variation in size and shape as it affects the use of fire brick," by JAMES R. ALLAN (5 pp); (*b*) "Variability, a general law of nature," by A. E. R. WESTMAN (2 pp); (*c*) "Causes of variation in size and shape of fireclay brick," (11 pp); (1) "Variation in shrinkage of clays," by E. H. VAN SCHOICK, (2) "Variation in size of fireclay brick due to firing," by GEORGE A. BOLE, (3) "Influence of moisture variations on the size and shape of fire brick," by L. C. HEWITT, (4) "Variation in process of manufacture," by CECIL E. BALES, (5) "Variation in size due to variation in molding pressure," by RAYMOND E. BIRCH, and (6) "Effect of kiln atmosphere on the size of refractories," by STUART M. PHELPS; (*d*) "Control of variation in size and shape of fire brick," by GEO. S. DIVELY (5 pp); (*e*) "Measurement of brick and the determination of warpage," by STUART M. PHELPS (3 pp).

Slovakian magnesite brick. A. STRASSER. *Feuerfest*, **7** [6], 81–84 (1931).—Foundries require magnesite products in which the crystallizing and sintering processes are completely ended during the production firing: this is only obtained with a material of a minimum Fe_2O_3 content. Magnesite brick with 5 to 7% Fe_2O_3 have proved best in kiln operation. With suitable preparation of the raw material they show the most de-

sirable properties, *i.e.*, high stability and minimum shrinkage. The production of Slovakian magnesite brick in the new plant at Lovinobána, which is described, is based on this principle. M.V.K.

Manufacture of silica brick. C. SCHILLING. *Feuerfest*, **7** [6], 86–87 (1931).—Notes from practical experience on the molding, mixing, and firing of silica brick are given. M.V.K.

New insulating fire brick. BABCOCK & WILCOX CO. *Ceram. Ind.*, **17** [2], 145–46 (1931); *Amer. Glass Rev.*, **50** [41], 12 (1931); *Pit & Quarry*, **22** [9], 73 (1931); for abstract see *Ceram. Abs.*, **10** [9], 646 (1931). W.W.M.

Brick and retort settings. ALFRED B. SEARLE. *Gas Eng.*, **6**, 305–306 (1931); *Refrac. Jour.*, **7** [7], 364 (1931).—The recent improvements in the production of brick for retort settings are discussed, with special reference to the effect of heat, the "after-expansion" test, and the use of insulating brick made principally of highly porous material such as kieselguhr. See also *Ceram. Abs.*, **10** [2], 124 (1931). E.P.R.

Ardonit-Siliment, muffle cement. WILHELM LINKE. *Emaillewaren-Ind.*, **8** [27], 212–13 (1931).—Ardonit-Siliment is a cement for sealing joints and fissures in muffles during operation, and for sealing recuperators, valves, grog masonry, etc. It is resistant to heat and sudden temperature change and it has a high mechanical solidity. For use, water is stirred with the paste. M.V.K.

Molding refractory products (fire brick and blocks). P. P. BUDNIKOFF, S. A. SHICHAREVICH, AND I. G. SHACHNOVICH. *Feuerfest*, **7** [6], 92 (1931); for abstract see *Ceram. Abs.*, **10** [6], 433 (1931). M.V.K.

Protection by refractory materials. A. C. *Rev. mat. constr. trav. pub.*, No. 260, pp. 90–91*B* (1931).—The considerations of resistance to abrasion, sagging, chemical reaction with products fired, and spalling govern the choice of refractories from the following types: clay, high silica, high alumina, dolomite, silicon carbide, chromite, zirconia, zircon, and graphite. M.Y.H.

Dolomite and chromite refractories vs. magnesite. PAUL M. TYLER. *Brick Clay Rec.*, **79** [2], 80–82 (1931).—Chrome brick and dolomite, due to lower costs, are displacing magnesite and magnesite brick used in steel furnaces to a noticeable degree. The output of chrome brick has grown from about 10% to equal or greater than that of magnesite brick in the past five or six years. Dolomite is being used for basic furnace bottoms instead of the more expensive dead-burned magnesite. E.J.V.

Study of refractory materials. III. COLIN PRESSWOOD. *Blast Fur. Steel Plant*, **19** [8], 1152–54 (1931).—Causes of spalling and methods for overcoming these troubles are discussed. The laboratory investigations on spalling are briefly reviewed. Various slag tests which can be used are compared and discussed briefly. For Part II see *Ceram. Abs.*, **10** [9], 664 (1931). E.J.V.

Examination of refractory products. V. MARCEL LÉPINGLE. *Rev. mat. constr. trav. pub.*, No. 260, pp. 87–89*B* (1931).—A method is given for calculating density, porosity, and permeability and their relative importance is discussed. Methods for measuring thermal conductivity and specific heat are given, together with two tables of values of specific heats of refractories at various temperatures and the coefficients of thermal conductivity. Results of research on the electric conductivity of listed substances will be useful in the construction of laboratory apparatus. For previous abstracts see *Ceram. Abs.*, **10** [8], 573 (1931). M.Y.H.

Slagging of refractories. IV. H. SALMANG AND F. SCHICK. *Refrac. Jour.*, **7** [6], 328 (1931); for abstract see *Ceram. Abs.*, **10** [5], 353 (1931). E.P.R.

Action of slag on refractory masonry and grates. ANON. *Feuerungstechnik*, **19** [7], 114–15 (1931).—An explanation of the destructive action of slag and ash on refractory masonry and iron grating is given. M.V.K.

Thermal expansion of refractory materials. R. V. WIDEMAN, A. JOURDAIN, AND H. CASSAN. *Refrac. Jour.*, **7** [7], 364 (1931); see also *Ceram. Abs.*, **10** [7], 506 (1931). E.P.R.

Correspondence on sillimanite. M. C. BOOZE. *Blast Fur. Steel Plant*, **19** [7], 1014–16 (1931).—In a discussion of the article "Use of sillimanite as material for furnace covers" (see *Ceram. Abs.*, **10** [8], 578 (1931)), B. points out that the information therein contained is apt to be misleading and cites examples of use of this material in this country with excellent results, completely opposite to those reported in the article in question. E.J.V.

Refractory linings for upright kilns for lime and cements. E. DE LA FOLLYE DE JOUX. *Rev. mat. constr. trav. pub.*, No. 260, pp. 177–79 (1931).—An ideal dimension of 25 x 25 x 22 to 25 cm. is suggested for refractory brick. It is recommended that two concentric linings be used, one of red brick, the other of refractory. Three zones are distinguished in every kiln: the preheating zone, the firing zone, and the cooling zone. A refractory of different quality is needed for each zone. Three cases are considered, *viz.*, (1) a kiln for rich lime, (2) a kiln for hydraulic lime, and (3) a kiln for cement. The following conclusions are drawn: (1) In the preheating zone the brick must be non-alkaline and high in mechanical resistance. Refractory properties are of secondary importance. (2) In the firing zone, the brick must be alkaline with the greatest refractory value and with mechanical resistance at high temperatures. For cement kilns, the melting point must be as high as possible. (3) In the cooling zone, brick may be less refractory but must have the same mechanical strength as in (2) and must have a high spalling resistance. M.Y.H.

Refractory materials for lead-refining furnaces. EDMUND RICHARD THEWS. *Feuerfest*, **7** [6], 84–86 (1931).—After discussing the special conditions in lead refineries and the action of the molten lead and the superheated antimony slag on the material of the furnace, T. reviews technical literature on the properties of new refractory materials. The high cost of most of these limits their use. A comparison of high-grade fire brick with magnesite brick shows that the former is preferable not only because of its superior technological properties but also because of its lower cost. Practical advice is given for preventing excessive damage from the antimony slag. M.V.K.

Lining for electric furnaces. LACLEDE-CHRISTY CLAY PRODUCTS CO. *Brass World*, **27** [7], 156 (1931).—A new lining material for electric furnaces has been placed on the market known as "Furnaseal C-8 (Super-Ram)" and is suitable for lining complete furnaces as well as for patching linings of furnaces operated at high temperatures for metal melting. Monolithic linings are produced from the new material and patches made with it become homogeneous with the lining. The makers stress its high slag-resisting qualities. E.P.R.

Refractories for electric furnaces. ALFRED B. SEARLE. *Refrac. Jour.*, **7** [7], 364 (1931); for abstract see *Ceram. Abs.*, **10** [7], 504 (1931); see following abstract. E.P.R.

Refractory materials for electric furnaces. III. Melting nickel and its alloys. A. B. SEARLE. *Metal Ind.* [London], **38** [23], 569–71 (1931).—Desirable properties of lining materials, lists of suitable materials, etc., for use in the melting of Ni and alloys are given. For Part II see *Ceram. Abs.*, **10** [9], 644 (1931). (*Bull. Brit. Non-Ferrous Metals Research Assn.*)

Ironless induction furnaces. R. HADFIELD AND R. J. SARJANT. *Fuel Econ. Rev.*, **10**, 71–77 (1931).—A concise account, including refractories, power consumption, economic factors, and costs, together with a long bibliography, is given. See also *Ceram. Abs.*, **10** [1], 44 (1931). (*Bull. Brit. Non-Ferrous Metals Research Assn.*)

Refractory materials for the induction furnace. J. H. CHESTERS AND W. J. REES.

Iron & Steel Inst., 16 pp. (May, 1931), advance copy; for abstract see *Ceram. Abs.*, **10** [6], 435 (1931). (*B.C.A.*)

Cupola linings. J. ROBITSCHEK. *Refrac. Jour.*, **7** [7], 364 (1931); for abstract see *Ceram. Abs.*, **10** [4], 273 (1931). E.P.R.

French bauxite production and trade. JOHN A. GAMON. *Commerce Repts.*, No. 28, pp. 107–109 (1931).—France is the leading producer of bauxite. There is a great difference in French bauxite, depending upon the chemical composition. Three classes can be considered: (1) normal bauxite, fair quality with 55 to 60% alumina and high-grade ore with over 60% alumina, total impurities not to exceed 20% excluding the combined water content, the chief impurities, ferric oxide, silica, and titania, not to exceed 5% each; (2) white or siliceous bauxite, upward of 55% alumina and not more than 20% impurities excluding combined water. Silica varies from 5 to 20%, ferric oxide less than 5%, titania up to 5%. This class is more frequently used for chemical purposes, for the preparation of alum and other aluminium salts. (3) Red bauxite with an alumina content upward of 52%, ferric oxide between 10 and 25%, silica less than 5%, titania normally less than 5%, commonly used by the aluminum reducing companies. The principal uses of bauxite in France are the manufacture of aluminum, manufacture of cement "fondu," manufacture of abrasives, manufacture of refractory products and hydraulic refractory cement, manufacture of chemical products, and the purification of petroleum. Cement fondu absorbs approximately 30% of the bauxite used in France. The companies exploiting French bauxite are discussed, as is its export and destination. E.J.V.

Bauxite in Puglia. CREMA. *Boll. del R. Ufficio Geologico d'Italia*, No. 3 (1931); *Giorn. chim. ind. applicata*, **13** [6], 291 (1931).—The results of researches on the bauxite deposits in the region of Otranto and the promontory of Gargano are summarized. The chemical composition of the bauxite is given. M.V.K.

Concerning bauxite. ANON. *Blast Fur. Steel Plant*, **19** [8], 1150–52 (1931).—Bauxite is used in the production of refractory materials, abrasives, and chemicals. France is one of the largest producers of bauxite, having estimated deposits of 60,000,000 metric tons. About half of the production of France is consumed in France and the remainder is exported. E.J.V.

University of Sheffield. ANON. *Refrac. Jour.*, **7** [7], 346 (1931).—An interesting departure in the new program of forthcoming lectures in connection with the refractory and brick trades is the arrangement of a practical laboratory course for workers in the clay trades, which will be given by W. J. Rees with the assistance of T. Lynam. The instruction under this head will cover a wide selection of subjects connected with the treatment of clays and the study of the general properties of the materials used in the manufacture of fire brick and building brick. Twenty demonstrations will be held in the laboratories of the Refractories Department of the University. This is the first occasion on which a practical course has peen provided for clayworkers. E.P.R.

Visit of English Ceramic Society in Germany. ANON. *Refrac. Jour.*, **7** [6], 299–305; [7], 331–38 (1931).—The Refractories Industry excursion to Germany under the guidance of J. W. Mellor is described in detail. The outstanding features of each organization visited is discussed. See also this issue p. 739. E.P.R.

Visit of the Coke Oven Managers' Assn. ANON. *Refrac. Jour.*, **7** [7], 343–46 (1931).—This report shows in detail the various stages in the manufacture of silica goods at the Meltham Works. E.P.R.

CIRCULAR

Magnesite. PAUL M. TYLER. Bur. Mines, *Information Circ.*, No. 6437, 63 pp. (1931).—Magnesite is of importance primarily as a refractory material for lining steel

furnaces, although substantial amounts are used in the production of flooring compositions and other building materials and for certain chemicals, notably Epsom salts. The present report gives information on the uses of this material, methods of mining and treatment, brickmaking, production, imports and exports, consumption and supply, and markets and prices. It also contains a bibliography and lists domestic producing manufacturers of magnesite brick and magnesite importers and dealers. See also *Ceram. Abs.*, **9** [5], 380 (1930). R.A.H.

PATENTS

High-temperature electric heating furnace. JOHN D. MORGAN. U. S. 1,803,282, April 28, 1931. A heating chamber having walls, including an inner layer of a heat-conducting refractory mixture containing silicon and zircon and having a heat conductivity at least twice that of fire clay at temperatures of 2000°F, and a refractory heat-insulating layer containing zircon having a high percentage of voids surrounding the conducting layer.

Treating carbonaceous articles. MICHAEL J. MARCIN. U. S. 1,804,361, May 5, 1931. A process of treating carbonaceous articles comprising embedding the articles in a mixture of 63 parts by weight of flint to 26 parts by weight of finely divided coke, placing the mass in an induction furnace, and passing a current through the furnace to raise the temperature sufficiently above the vaporization point of flint and below the vaporization point of carbon to form an adherent surface layer of uniform, homogeneous, and hard silicon carbide.

Producing tantalum and other rare refractory metals by electrolysis of fused compounds. FRANK H. DRIGGS. U. S. 1,815,054, July 21, 1931. In an article of jewelry, a frame having an opening, a pin-tongue support having a base seated against the back of the frame and provided with an opening registering with the opening therein, and a gem setting provided with a reduced neck portion inserted through the opening in the frame and the opening in the pin-tongue support and riveted over on the base of the latter to secure the parts permanently in place.

Furnace construction. JOHN E. ANDERSON. U. S. 1,815,891, July 28, 1931. In a furnace, a retaining wall, a polylithic lining, a monolithic lining, means for transmitting a major portion of the weight of the polylithic lining to the retaining wall, and means for holding the monolithic lining against movement away from the wall while permitting independent expansion and contraction thereof.

Manufacture of zirconium compound refractories. GEORGE J. EASTER. U. S. 1,816,006, July 28, 1931. The process of manufacturing refractories which consists in fusing a compound of zirconium, crushing the fused material, roasting it in an oxidizing atmosphere, forming a refractory body of the material thus treated, and firing the body.

Retaining and sealing furnace structure. ROBERT L. FRINK. U. S. 1,816,322, July 28, 1931. In a construction, the combination of heat-resistant members having opposed surfaces provided with recesses, and a locking member fused in such recesses, the locking member being glasslike in character.

Refining ores or products containing aluminium oxide. TURE ROBERT HAGLUND. U. S. 1,816,842, Aug. 4, 1931. The process of refining ores or products containing aluminium oxide which comprises converting impurities of oxide of iron into sulphides of iron by treating the material, before fusing, in a heated condition in a reducing atmosphere with a gaseous sulphurating agent, and fusing the treated material together with a reducing agent.

Lining brick for rotary cement kilns. HACHIRO SAITO. U. S. 1,817,421, Aug. 4, 1931. A lining brick for kilns comprising a brick composed of super-refractory material, the brick being provided with a plurality of recesses and a plurality of clay brick in

the recesses, the surfaces of the refractory brick and clay brick being in alternate positions on the face of the lining brick.

Partition for separating the products of fusion electrolysis of metallic chlorides. ROBERT SUCHY, KARL STAIB, AND WILHELM MOSCHEL. U. S. 1,818,174, Aug. 11, 1931. A partition for separating the products of fusion electrolysis of metallic chlorides comprising a base plate of porous refractory material and a surface layer on the base plate consisting of a plurality of plates of nonconductive ceramic material of dense structure, the plates being fitted together and mounted on the base plate by means of a suitable binder.

Method of making refractory. DONALD W. ROSS AND JAMES M. LAMBIE. U. S. 1,818,506, Aug. 11, 1931. The method of making refractories which consists of mixing silica-alumina materials, molding, and firing to the point where the mass contains at least 40% glass, the fired product containing not less than a total of 70% silica nor more than a total of 6% of fluxes other than alumina.

Coke oven. CHARLES H. HUGHES. U. S. 1,818,713, Aug. 11, 1931. In a by-product coke oven, a coking chamber and heating flues, a part of the walls of each of the heating flues being adjacent to the coking chamber, the walls adjacent to the coking chamber comprising a high heat-transmitting material consisting of approximately 90% silicon carbide and approximately 10% of a refractory bonding material, and the opposite walls of the heating flues comprising a heat-insulating material consisting substantially of zirconia.

Furnace-wall construction. LOUIS H. HOSBEIN. U. S. 1,818,802, Aug. 11, 1931. In furnace-wall construction, the combination of wall refractories supported in groups, anchoring members retaining the refractories of a group in association, and heat-diffusing members bedded between juxtaposed refractories, the heat-diffusing members engaging the anchoring members and having portions exposed to air outside the wall.

Manufacturing anhydrous aluminium chloride. GEORGE FREDERICK BRINDLEY. U. S. 1,818,839, Aug. 11, 1931. The process of manufacturing anhydrous aluminium chloride involving a mixture of sodium chloride and calcium chloride, heating the mixture to its melting point, allowing the fused mass to react with anhydrous aluminium sulphate, collecting the fumes of aluminium chloride resulting from the interaction of the chloride mixture and aluminium sulphate, and condensing them.

Making refractory article. RICHARD H. MARTIN. U. S. 1,818,903, Aug. 11, 1931. (1) A refractory article comprising a body of bonded, refractory, granular material, and a relatively thin coating thereon containing a major proportion of a zirconium compound and a fusible constituent. (2) A refractory body comprising ceramic bonded, refractory, granular material, and a relatively thin coating thereon containing a predominating amount of zirconia and a smaller amount of magnesia with associated impurities fired *in situ* to form a relatively dense coating which is substantially impervious to kiln gases under normal firing conditions.

Silicon carbide refractory article. RICHARD H. MARTIN. U. S. 1,818,904, Aug. 11, 1931. The method of forming a protective coating on a refractory article containing silicon carbide which comprises coating a face of the article with a compound, a considerable portion of which comprises magnesia and alumina, and thereafter appropriately firing the article to cause the magnesia and alumina to combine and form a dense coating which will protect the silicon carbide from rapid decomposition.

Furnace roofs. E. BLOCK. Brit. 352,191, July 15, 1931.

Manufacture of refractory products from magnesium silicates. METALLGES. AKT.-GES., AND V. M. GOLDSCHMIDT. Brit. 352,881, July 22, 1931.

System of construction of suspended furnace roofs. E. STRUNK AND H. WINDSOR & CO., LTD. Brit. 353,682, Aug. 6, 1931.

Refractory products. CHAMOTTEFABRIK THONBERG A.-G. Fr. 698,876, July 12, 1930. Refractory products are made by using a refractory earth or quartz with feldspar or dolomite and a residual sulphitic or molasses lye, molding, and baking. The feldspar or dolomite may be replaced by chlorides or sulphates of alkali or alkaline earth metals. (*C.A.*)

Crucibles. CARBORUNDUM CO. Fr. 699,562, July 4, 1930. Crucibles or other refractory objects are made so that the heat conductivity through the walls is greater than that in the direction of the axis of the crucible, by making the crucible of a mixture containing laminae particles placed in a direction substantially horizontal. The particles may be of natural graphite. (*C.A.*)

Refractory brick. GENERAL REFRACTORIES CO. Fr. 699,598, July 11, 1930. Refractory brick of high density and low porosity contain a mixture of particles of appreciable dimensions and particles of smaller dimensions, the amount of particles of intermediate size being zero or very small. The particles are obtained by screening the material through 2 screens, the one for the smaller particles containing about $1^1/_2$ times as many holes as the one for larger particles, *e.g.*, 19.7 to the centimeter and 11.8 to the centimeter. The proportion of the particles to give the best density for the brick is obtained by means of graphs on which are traced lines of equal density starting with a binary or ternary mixture. (*C.A.*)

Refractory lining for metallurgical furnaces. JEGOR I. BRONN. Ger. 524,173, July 16, 1926. The lining comprises chromite or basic or neutral mixtures rich in Cr_2O_3, bound with a cement rich in Al_2O_3. (*C.A.*)

Terra Cotta

Modernized building materials. DANIEL BOYDE CATHCART. *Arch. Forum*, **55** [2], Part 2, 241–46 (1931).—New developments in the manufacture of terra cotta, cement, and gypsum products are being effected rapidly. Terra cotta is favored with many advantageous characteristics at the outset. It is fireproof and permanent and when glazed, presents a waterproof surface easily cleaned with soap and water. A recent development is the machine-made ashlar block. Patented clinch mortar joints at the ends of the blocks lock them together securely. Through a radical departure from orthodox methods of handling clay at the mill, a new vitreous product not yet placed on the market can, due to positive control of its manufacture, be made dense and strong or lightweight and less compact at will. Equipment and processes similar to those of the steel industry are used to press or roll the material into any desired form during a certain period of fluidity coincidental with vitrification. There is also in the process of development a system of producing aerated, vitrified clay. This material may be made to weigh from 10 to 60 lb./cu. ft.; but a medium weight of approximately 30 lb./cu. ft. should be used for general purposes. Salt or slip glazes may be applied to the material at slightly extra cost or, if it is desired to retain the excellent acoustic properties of the material, it may be colored by another special process. Of interest to the architectural designer and colorist is the use of metallized terra cotta. Pure metal of almost any kind is now being applied to plain or richly molded surfaces by means of a recently perfected apparatus. The tool, using acetylene and oxygen gases as fuel, melts and atomizes metal fed into it in the form of wire and, with compressed air supplied at 50 cu. ft./minute (at 50 lb./sq. in. pressure), sprays the metal onto the surface to be coated. E.P.R.

Glazed brick and terra cotta. ANON. *Clay-Worker*, **96** [1], 21 (1931).—The growing demand for enameled and glazed brick, as well as glazed terra cotta, is directing attention to these products in the Eastern district, and a number of producers are

expected to step into this field. Enameled brick is replacing ceramic wall tile on some jobs. E.J.V.

Vitrified terra cotta. PAUL E. COX. *Bull. Amer. Ceram. Soc.*, **10** [8], 265–67 (1931).—C. deplores the fact that the firing treatment of terra cotta has been lowered from that which produced a hard product to one so soft that the grog readily falls out when a piece is broken in handling. This has resulted from the use of soft majolica glazes to meet demands for color and the product is not satisfactory from the standpoint of endurance. It is pointed out that though higher firing would raise the cost, the improvement in quality would make surer markets for the materials. Porcelain glazes could be used for the coloring media on this vitrified product. Some experiments in production of vitrified terra cotta are briefly mentioned. E.J.V.

New ceramic plating tank. GENERAL CERAMICS CO. *Brass World*, **27** [7], 156 (1931).—A new product offered to the electroplating and metal-finishing industries is the "Ceramit" tank. "Ceramit" is stated by the makers to be a ceramic material of maximum density, the absorption coefficient being about 0.01%, which is approximately that of porcelain. Its advantage is that it can be formed into shapes of wide variety, mechanical strength being high, and resistance to changes in temperature being not less than ordinary stoneware. An important application of "Ceramit" is in tanks for electrolytic refining of precious metals. It may also be used in tanks for the separation of precious metals and equipment used in electrical and electrochemical processes, including copper plating. "Ceramit" is not affected by any chemical except hydrofluoric acid. A new acid-proof brick is also offered by General Ceramics. It is a dense, strong, vitrified product, with smooth, attractive acid-proof glaze on the exposed side. Superior quality and accurate shape are stressed. E.P.R.

Acid-proof brick linings. L. KOEGEL. *Chem. Fabrik*, No. 26, pp. 285–87 (July, 1931).—Acid-proof lining is not always waterproof. Some degree of porosity can always be found and water in amounts of 0.5 to 1.5% of its weight is adsorbed by even the best kind. The action of acid is soon stopped either by the effect of capillarity or by clogging the pores with iron salts. The cement employed for the linings consists usually of quartz powder, barite, and some other inorganic material brought to a plastic consistency by mixing with water glass. This must be dried slowly which is done best by exposing the lined container to a temperature of 50 to 60° for several days. Otherwise the lower cement layer remains soft even after years of use. The dry cement can again soften when water or steam comes in contact with it before contact with acid. It is necessary to paint the plates with 25 to 30% acid several times. The free alkali is thereby combined. This must not be done before the cement is hardened to a sufficient degree or silicic acid will precipitate and render the cement fragile. J.G.T.

Machine-made terra cotta faces McGraw-Hill Bldg. ANON. *Brick Clay Rec.*, **79** [1], 30 (1931).—Construction details of the McGraw-Hill Bldg., a 33-story structure in New York for which the Federal Seabord Terra Cotta Co. is supplying machine-made terra cotta, are described. Methods of handling the terra cotta are discussed. Illustrated. See also *Ceram. Abs.*, **10** [6], 441 (1931). E.J.V.

Continental Bldg., New York. ANON. *Arch. & Bldg.*, **58** [4], 86 (1931).—This building is constructed of white marble, terra cotta, and enameled brick and rises to a height of forty-two stories. E.P.R.

Flowerpot industry. ANON. *Ceram. Ind.*, **17** [2], 114–15 (1931).—The Pfaltzgraff Pottery Co., York, Pa., which produces 12 million flowerpots a year is described. W.W.M.

New castles in old Spain. W. FRANCKLYN PARIS. *Arch. Forum*, **55** [1], Part 1, 73–78 (1931).—At the Ibero-Americana Exposition in Seville, the dominating structure is the semicircular edifice within whose arc is located the Plaza de España. It is

4 stories high, 200 m. long, and covers an area of 50,000 sq. m. Two lofty towers rise to a height of 80 m. at extreme ends of the hemicycle and an arcaded gallery of brick, marble, and brilliant polychrome tile runs the length of the entire façade. A use is made of the ceramic tile of Triana in the balustrade as well as in a series of 49 monumental benches. The Palace of Decorative Arts has a profusion of Azulejos, or colored tile ornamentation, with brick marble and gesso (low-relief sculpture of plaster) entering into the composition as its chief elements. E.P.R.

BOOKS

Modern Architecture. Edited by J. G. WATTJES. "Kosmos," Amsterdam, 1927. Three hundred and sixty-three photographs and plans of buildings in Europe and the U.S. are given. Water-power stations, museums, assembly halls, moving-picture houses, observatories, country homes, and city apartments are illustrated. The earliest date is 1908. Introductions are in the Dutch language, but notes below the pictures are given also in English. (*D.I.*)

Modern Churches in Europe and America. Edited by J. G. WATTJES. "Kosmos," Amsterdam, 1931. Three hundred and three photographs and plans of modern churches in Europe and America, most of them erected within the last ten years, are presented. An English introduction comments on the necessity of adapting symbolic and aesthetic requirements to the present day. (*D.I.*)

Gargoyles, Chimeres, and the Grotesque in French Gothic Sculpture. LESTER B. BRIDAHAM. Architectural Book Publishing Co., New York, 1930. Illustrated. (*D.I.*)

Modern Building Industry in Europe and America. BRUNO TAUT. Julius Hoffmann, Stuttgart, 1929. The book includes a selection of photographs of buildings which are grouped by use rather than by country. (*D.I.*)

New Journal of Standards for Acid-Resisting Stoneware Cylindrical and Conical Stationary Vessels. (Neue Normenblätter für säurefestes Steinzeug.) ANON. Beuth, Berlin, 1931. 14 pp. Reviewed in *Keramos*, **10** [13–14], 361 (1931). M.V.K.

PATENT

Preparing acid-proof cementing or lining compositions. KARL FRANK AND KARL DIETZ. U.S. 1,818,888, Aug. 11, 1931. The process for preparing acid-proof compositions which comprises adding pulverized silicon to a water-glass cement.

White Ware

Effect of firing temperature on the dielectric strength of porcelain. A. J. MONACK AND L. R. SHARDLOW. *Jour. Amer. Ceram. Soc.*, **14** [9], 603–607 (1931).

Modulus of elasticity as an indication of the uniformity of electrical porcelain. A. J. MONACK. *Jour. Amer. Ceram. Soc.*, **14** [9], 608–16 (1931).

Mechanical and thermal shock tests on ceramic insulating materials. H. M. KRANER AND R. A. SNYDER. *Jour. Amer. Ceram. Soc.*, **14** [9], 617–23 (1931).

Metal marking of whiteware glazes influenced by sulphur and carbon in kiln atmospheres. R. F. GELLER AND A. S. CREAMER. *Jour. Amer. Ceram. Soc.*, **14** [9], 624–30 (1931).

Additional data on stoker-fired tunnel kiln. G. G. KENT AND E. M. RUPP. *Jour. Amer. Ceram. Soc.*, **14** [9], 640–42 (1931).

Materials used in the manufacture of porcelain. A. H. FESSLER. *Fuels & Fur.*, **9** [2], 231–34 (1931).—Porcelain embraces a large series of ceramic ware having as a

common characteristic varying degrees of translucency. The Chinese are generally thought to have produced the first porcelain in the 9th Century. Since then much new equipment has been devised to accomplish the same results more efficiently. Ball mills, filter presses, hot presses, jiggers, etc., may be mentioned among these. Porcelain may be classified as being soft or hard. This classification is based on the refractoriness of the body; the hard porcelain being more refractory than the soft. The soft porcelain is fired under cone 11 and the hard porcelain over cone 12. The ingredients used in hard porcelain are kaolins, ball clays, flint, and feldspar. These are also constituents of soft porcelain with the addition of either whiting, bone ash, soda, or some metallic oxide. The raw materials are discussed. A.E.R.W.

Study of ball clays for ivory dinnerware bodies. G. A. LOOMIS. O. S. U. Eng. Expt. Sta., *News Bull.; Ceram. Ind.*, **16** [3], 258 (1931).—Work is being done on the investigation of American ball clays for use in semivitreous, ivory dinnerware bodies. The change from white to ivory bodies has made possible the substitution of the American ball clays for the more pure English ball clays. Clays being investigated are Kentucky strong type, Kentucky weaker type, Tennessee type, Mississippi type, and a combination of Kentucky strong and Missouri types. Tests on bodies containing these clays include impact test and quenching test on glazed specimens, shrinkage, absorption, dry and fired transverse strengths, and thermal expansion tests. W.W.M.

Substitution of feldspar by nepheline in ceramics. V. M. MERMYAKOV. *Ceramics & Glass*, **7** [3], 25 (1931).—Tests show that feldspar could be completely substituted in the manufacture of stamped electric armature ware by nepheline-sienite (from Hibin, containing about 1% of Fe_2O_3) and by nepheline-apatite waste, *i.e.*, waste from apatite production with about 3.5 to 4% of Fe_2O_3 and about 6% of P_2O_5. Approximately 4 parts of nepheline-apatite and 2 parts of nepheline-apatite waste are equal, in regard to flux content, to one part of potassium feldspar. In mechanical strength the nepheline body approaches that of the equivalent feldspar body. The color of the ware is pale gray. It is fired at cone 8 to 11. (*Trans. Ceram. Soc.* [Eng.])

Study English china clays. ANON. *Ceram. Ind.*, **16** [6], 544 (1931); for abstract see *Ceram. Abs.*, **9** [3], 206 (1930). W.W.M.

Colors for sanitary ware. ANON. *Commercial Stand. Monthly*, **7** [11], 354; **8** [1], 21 (1931); see also *Ceram. Abs.*, **10** [6], 442 (1931). E.J.V.

Heat-resisting ceramic bodies. TH. HERTWIG-MOEHRENBACH. *Sprechsaal*, **64** [30], 555–56 (1931).—Most of the tableware will crack when exposed to direct heating. Some recipes are given of ceramic bodies containing magnesia which did not crack when suddenly cooled from high temperatures. W.M.C.

Use of titanic acid TiO_2 in porcelain glazes. ADOLF HEINZ. *Keramos*, **10** [12], 309–12 (1931).—By mixing porcelain glazes with titanic acid and firing with a reducing fire, a great scale of colors is obtained. The development of the colors depends on whether a white body or a hard-fired cobalt base constitutes the ground. Tables give the results obtained by firing compounds containing TiO_2 to Seger cone 8 and 14. M.V.K.

The Canadian potter modernizes. ANON. *Ceram. Ind.*, **17** [2], 133–34 (1931).—The new plant of Canadian Potteries, Ltd., at St. Johns, Quebec, is described. W.W.M.

Prince George's visit to the Potteries. ANON. *Pottery Gaz.*, **56** [650], 1105–13 (1931).—Prince George spent two days in the Stoke-on-Trent district, visiting six well-equipped factories, three of which are identified with the production of high-class domestic pottery, while the other three produce sanitary pottery, tile, and electrical porcelain. The various plants are described. Illustrated. E.J.V.

PATENTS

Closet bowl. ALVA W. DALLAS. U. S. 1,816,362, July 28, 1931. A closet bowl having a trap with its siphon discharge at the front thereof, the bowl having a cushioning chamber with a communicating aperture in the path of travel of water passing from the bowl to the trap and in spaced relation to that part of the bowl containing water when flushing is inactive, whereby when flushing occurs, the water overflowing the normal water-holding capacity of the bowl forcefully contacts the wall of the chamber and exerts force on air in the chamber and its aperture.

Insulator. GUSTAV JANSSON. U. S. 1,816,852, Aug. 4, 1931. In an insulator, the combination of two concentric insulating tubes having an annular space between them and a loose granular filler of insulating material contained in the annular space.

Lavatory basins, baths, sinks, bidets, etc. TWYFORDS, LTD., AND J. T. WEBSTER. Brit. 352,253, July 15, 1931.

Manufacture of porcelain for cooking. G. FUSCHI AND M. KORACH. Brit. 352,723, July 22, 1931.

Manufacture of porcelain. BRITISH THOMSON-HOUSTON CO., LTD. Brit. 352,763, July 22, 1931.

Making electric insulators. INTERNATIONAL GENERAL ELECTRIC CO., INC. Brit. 353,632, Aug. 6, 1931.

Porcelains. PORCELAINERIE DE LESQUIN. Fr. 700,228, Aug. 9, 1930. In the manufacture of ceramic material, particularly electrotechnical or ordinary porcelain, all the flint and a part of the feldspar usually used is replaced by pyrophylite, *e.g.*, china clay 34, ball clay 13, feldspar 37, and pyrophylite 16%. See also *Ceram. Abs.*, **9** [8], 656 (1930). (*C.A.*)

Equipment and Apparatus

Dust- and sulphur-removal plant. ANON. *Elec. Rev.*, **109** [2797], 16 (1931).—The "Modave" dust and sulphur arrestor is being introduced in England by Alfred Herbert, Ltd. The efficiency of the apparatus is not affected by the size or mass of the dust particles and there is no wear because there are no moving parts. The apparatus consists of an upper tank in which a constant level of water is maintained by a ball valve. Orifices in the bottom of the tank are connected with tubes which lead into elements. The elements are closed at the bottom and square in section with their outer surfaces concave. The elements are mounted vertically in rows and so arranged that the flue gases follow a tortuous path through the nest. They are enclosed in a steel casing. Beneath the elements is a hopper-shaped tank with a valve at the bottom. The water in this tank is kept constantly at such a level that the bottoms of the elements dip into the water. Water flows through the orifices in the upper tank into the hollow elements, overflows, and runs down all four sides, resembling somewhat a film on the exterior walls, into the bottom tank. The gases entering the apparatus normal to the axes of the elements come into contact with the wet surfaces to which the dust particles stick and are washed down to the bottom tank. The dust is then carried away through a valve and is run either to waste or to settling ponds. The efficiency worked out to be 90.2% for ordinary firing conditions. E.P.R.

Power equipment for brick plants. LAASER. *Tonind.-Ztg.*, **55** [57], 827–29; [58], 847–49; [59], 860–61 (1931).—Different factors which influence the choice of power equipment for brick plants are discussed giving the best heat economy not only for power but also for drying purposes. Steam engines, locomobiles, Diesel engines, and electric energy are compared giving the costs under certain assumptions. The different points to be kept in mind when using the power plants are outlined. See also *Ceram. Abs.*, **10** [5], 367 (1931). W.M.C.

What users should know about material handling. EDWARD J. TOURNIER. *Factory & Ind. Management*, **82** [2], 173–80 (1931).—Continuous handling processes of the Ford Rouge Plate Glass Co. are described and illustrated. See also *Ceram. Abs.*, **10** [7], 515 (1931). E.C.C.

Weighing while on the move. ANON. *Factory & Ind. Management*, **82** [2], 219 (1931).—An automatic weighing device installed in a roller conveyer system is described. E.C.C.

Antifriction bearings in conveyers. A. K. WEST. *Brick Clay Rec.*, **79** [2], 76–80 (1931).—The application of antifriction bearings to conveyers and some of the problems this presented at the beginning are discussed. The operating advantages of the antifriction bearings are enumerated and the various styles of mounting that have been developed for conveyer rollers are briefly described, with the peculiarities of each pointed out. See also *Ceram. Abs.*, **10** [5], 373 (1931). E.J.V.

Portable cranes. ANON. *Chem. Met. Eng.*, **38** [7], 417 (1931).—Several models of portable cranes, both hand- and motor-operated, have been announced as a new line by the Lewis-Shepard Co., Watertown Station, Boston, Mass. The cranes are of four types, including hinged, telescopic, revolving hinged, and revolving telescopic. The drives are hand-worm, hand-spur, and electric-worm. G.R.S.

Materials handling equipment. ANON. *Brass World*, **27** [7], 158 (1931).—The Mathews "ball transfer" is a new type of equipment designed to accommodate the movement of any object having smooth hard surfaces in any direction on a horizontal plane. Its application is not confined to any particular type of work or to any one industry. E.P.R.

Trackless floor trucks with loading device for greater height. FRIEDRICH RIEDIG. *Keramos*, **10** [13–14], 345–50 (1931).—New types of construction of trackless floor trucks with apparatus for piling or loading at greater height are described. See also *Ceram. Abs.*, **9** [12], 1074 (1930). M.V.K.

Brick delivery equipment. ANON. *Brick Clay Rec.*, **79** [2], 64–70 (1931).—Detailed information regarding the economy, ease of operation, and general advantages of the Fontaine brick delivery system, involving the use of large trucks and trailers, is presented from data obtained in actual operation. Illustrated. See also *Ceram. Abs.*, **10** [9], 542; 554 (1931). E.J.V.

Heavy-duty apron feeder. ANON. *Chem. Met. Eng.*, **38** [7], 420 (1931); for abstract see *Ceram. Abs.*, **10** [7], 513 (1931). G.R.S.

Water-sealed pump. ANON. *Chem. Met. Eng.*, **38** [7], 417 (1931).—The pumps were originally developed for handling ash-laden water against heads up to 400 ft., but are now being offered for the pumping of all abrasive-laden liquids. A cutaway view of the pump is shown. It is obtainable in both horizontal and vertical models and is constructed of a steel alloy said to be highly resistant to erosion. G.R.S.

Corrosion-resisting pumps. ANON. *Chem. Met. Eng.*, **38** [7], 418 (1931).—The pump is a modification of a standard high-pressure, single-stage turbine pump in a variety of corrosion-resisting metals including stainless steel, monel metal, Ni-resist metal, ascoloy, everdur, illium, and special bronze. G.R.S.

Automatic spraying units. PAASCHE AIRBRUSH CO. *Ceram. Ind.*, **17** [2], 146 (1931).—An automatic air coloring machine for banding, shading, and decorating chinaware and an automatic tile-glazing unit are described. See also *Ceram. Abs.*, **10** [4], 288; [6], 446 (1931). W.W.M.

High-safety factor in inclosed motor. ANON. *Elec. World*, **98** [4], 176 (1931).—The "klosd-tite" motor announced by the Sterling Electric Motors, Inc., Los Angeles, Calif., is protected from liquids, chips, grit, etc. It is completely ventilated and can be operated in any position desired. G.R.S.

Closed drying kiln. v. Droste. *Werksleiter*, **5** [3], 49–52 (1931); *Feuerfest*, **7** [6], 93 (1931).—The electrically heated, movable closed drying kiln is economical and is used for all types of drying. M.V.K.

Micro-furnace for temperatures above 1000°. H. S. Roberts and G. Morey. *Instrument World*, **3**, 290 (1931); for abstract see *Ceram. Abs.*, **10** [5], 374 (1931). H.H.S.

Firing rack for decorated ware. Anon. *Keramos*, **10** [12], 307–308 (1931).—The rack is made of highly refractory cast iron and is stable on heating to 1300°. The ware is securely held but the outer edge hangs free, which prevents any damage to the gold or colored border. The rack is quickly filled and emptied and by adjusting the stands, plates of from 17 to 28 cm. in diameter can be fired in one rack. M.V.K.

Cold-working of platinum wires and the fibrous texture produced. G. Greenwood. *Z. Krist.*, **78** [3–4], 242–50 (1931).—The cold-working of platinum wires produces a fibrous structure. On investigation by rays of different penetrative powers, the interior zones of the wire were found more susceptible than the outer zones to the effects of cold-drawing. G.R.S.

Study of apparatus for cutting brick, etc. P. Renault. *Rev. mat. constr. trav. pub.*, No. 260, pp. 93–97*B* (1931).—Pug mills with lower control and the conditions in which they are used are described. Statistics are given for the performance of vertical pug mills of the following French factories: Chavassieux et Cie, Ets. P. Brandt, Pélerin, and Boulet et Cie. See also *Ceram. Abs.*, **10** [9], 653 (1931). M.Y.H.

The importance of the water separator in sandblasting. C. J. Stiers. *Metal Cleaning & Finishing*, **3** [5], 431–32 (1931).—The many sandblast difficulties resulting from the presence of too much moisture in the compressed air line may be guarded against by the installation of a good water separator. See also *Ceram. Abs.*, **10** [7], 512 (1931). E.J.V.

Closed-circuit grinding as an engineering problem. J. S. Vrabek. *Rock Prod.*, **34** [16], 90–95 (1931).—V. discusses the principles of grinding in the cement industry and describes open-circuit grinding and closed-circuit grinding (with a separator). The arguments for closed-circuit grinding are given with applications of it. The article is illustrated with photos, charts, and diagrams. W.W.M.

Modern grinding plant. J. C. Farrant. *Chem. Trade Jour.*, **88**, 97 (1931).—Grinding apparatus is classified in three groups, low, medium, and high-speed mills. The mills belonging to these classes are enumerated, and their suitability for grinding the different grindable materials is explained. The importance of removing from the mill all material which is sufficiently fine is discussed. The principles of the Krupp mill and its successors, the Hardinge mill and the Raymond mill, are outlined. (*Trans. Ceram. Soc.* [Eng.])

Mobile storage saves extra handling. E. D. Johnson. *Ceram. Ind.*, **17** [2], 118–19 (1931).—With the substitution of tunnel kilns for periodic kilns at the Homer Laughlin China Co., the output of the plant was increased and means were required for transit and temporary storage. A lift truck, skid bin, and platform system are used to eliminate rehandling during processing. W.W.M.

400-mesh wire cloth. Anon. *Pit & Quarry*, **22** [9], 78 (1931).—A world's record has been established by the Newark Wire Cloth Co., by making a 400-mesh wire cloth. It is said to be the finest wire cloth ever made. E.P.R.

Mining, crushing, and grinding method at the Giant cement quarry. S. G. McAnally. *Pit & Quarry*, **22** [9], 46–52 (1931); for abstract see *Ceram. Abs.*, **10** [8], 590 (1931). E.P.R.

An improved soil sampling tube. H. J. Harper. *Soil Sci.*, **32** [1], 65–68 (1931).—Several different tubes were designed and tested to overcome (1) friction between

expanded portion of tube and soil face, and (2) suction developed in moist soils as the tube is raised. Diagrams and photographs of the tubes are shown. G.R.S.

Gas-detecting instruments. ANON. *Chem. Met. Eng.*, **38** [7], 418 (1931).—One of the instruments made in several models for industrial, sanitary, gas company, and mining uses, will also determine the concentration of a known gas in a mixture of the gas and air. These instruments are said to be suitable for use with gases of all kinds, both inflammable and noninflammable, provided only that the specific gravity differs from that of air. G.R.S.

Siemens agriculture shaping machine in the ceramic industry. R. ARENBECK. *Tonind.-Ztg.*, **55** [53], 770–71 (1931).—It is shown that the small type of shaping machine recently developed for agricultural work may also be used in clay pits. W.M.C.

Reasons for faulty mouths of brick presses. ANON. *Tonind.-Ztg.*, **55** [53], 765–67 (1931).—It is pointed out that often bad results of brick are caused by faulty mouths of the presses used. Several sketches are given showing the effects on brick and drain pipes. Possibilities of getting good results are discussed. W.M.C.

Homemade mixture proves efficient for lubricating open gears. ANON. *Pit & Quarry*, **22** [9], 37 (1931).—Operators of cranes, excavating, and other machinery will find the following mixture especially efficient for open gears: white lead $^1/_2$ lb., cylinder oil $^1/_2$ gal., and flake graphite $^1/_2$ lb. This mixture adheres well to the gears and can be painted on with a brush, as required, at intervals of about five hours. The graphite and oil form the lubricating content of this mixture. The white lead acts as a binder. E.P.R.

Official changes in the active list of permissible explosives and blasting devices for June, 1931. ANON. 2 pp. Bur. Mines, *Rept. of Invest.*, No. 3123.—The addition of Liberty No. 2 and Liberty-Gel. L.F. to the list of permissible explosives tested under schedule 17*B* is noted. Requirements are given under which these explosives are permissible. See also *Ceram. Abs.*, **10** [6], 447 (1931). R.A.H.

Keeping iron magazines cool will avoid deterioration of explosives. ARTHUR LAMOTTE. *Pit & Quarry*, **22** [5], 53–54 (1931).—In the storage of almost every material used in blasting operations, it is necessary to avoid extremes of heat and cold. It is more important to avoid extremes of heat than of cold for the reason that modern high explosives are made of formulas which will withstand almost any low temperature encountered in the U.S. High temperatures and especially repeated alternations of high and low temperatures, such as occur in a region of hot days and cold nights, cause some dynamites to leak, which is dangerous, cause other types to set, which makes them difficult to detonate, and are likely to ruin any kind of fuse and even Cordeau. Excessive heat is also injurious to electric blasting caps. The type of magazine which most frequently causes trouble with explosives from becoming overheated is the iron magazine. One measure for keeping down the temperature in an iron magazine is to build a wooden roof over the magazine with a foot or two of air space between it and the iron roof. Another measure which has been found extraordinarily effective for decreasing the temperature of an iron magazine is to paint it with aluminum paint. E.P.R.

Adjustable work guide. FRANK P. ROGERS. *Abrasive Ind.*, **12** [8], 38 (1931).—The adjustable tool rest eliminates resetting. Illustrated. E.P.R.

Crank press for ceramics. GEORG UHRIG. *Keramos*, **10** [13–14], 351–52 (1931).—The adaptation of the crank (nonhydraulic) press in the manufacture of wall and floor slabs, is discussed and described. M.V.K.

New solenoid-operated valve. GENERAL ELECTRIC CO. *Amer. Glass Rev.*, **50** [41], 18 (1931).—A new solenoid-operated valve, designated CR-9507-A1, for con-

trolling liquids and gases under pressure has been announced by the General Electric Co. Some of the many uses for which the new valve is designed are for operating steam or air whistles, for remotely or automatically controlling the supply of oil or gas to furnaces, for automatically controlling the flow of liquids in connection with weighing machines, and for controlling the flow of water in cooling jackets on compressors. E.P.R.

Testing of building materials and the exposition of the German Association of Testing Machines. H. SPERBER. *Tonind.-Ztg.*, **55** [55], 799–802 (1931).—Some machines for testing building materials exhibited at the exposition of building at Berlin are shown and the qualities of the materials to be tested are outlined. W.M.C.

BOOK AND PAMPHLETS

Life Expectancy of Physical Property. E. B. KURTZ. The Ronald Press Co., New York. 205 pp. $6.00. Reviewed in *Elec. World*, **96** [3], 122 (1931).—K. has applied to the life problems of physical property structures, machinery, equipment, etc., the principles and methods used by life insurance actuaries in dealing with the problems of human mortality. He crystallizes recent advanced thinking upon the problems of depreciation and obsolescence combining the engineering and accounting aspects of the problems involved. The book is illustrated with charts and diagrams. All necessary data are presented in organized tabular form, useful life expectancy, renewals, etc., being included. G.R.S.

Pyrometers. BROWN INSTRUMENT CO. *Abrasive Ind.*, **12** [8], 40 (1931); *Amer. Glass Rev.*, **50** [44], 33 (1931); *Chem. Met. Eng.*, 38 [7], 419 (1931).—This catalogue contains 48 pages and is well illustrated. An introduction outlines the nature and field of the potentiometer principle as applied to pyrometry and shows how this principle is incorporated in the devices in question. Features of the instrument are fully described and it is pointed out that the devices are particularly applied to industrial needs involving measurement and control. See also *Ceram. Abs.*, **10** [9], 652 (1931). E.P.R.

Keystone safety lubricator. KEYSTONE LUBRICATING CO. *Pit & Quarry*, **22** [9], 71 (1931).—This pamphlet illustrates and explains by the question-and-answer method, the advantages and principal features of a centralized lubricating system for industrial machinery. Lubricating methods in cement and lime plants are featured. E.P.R.

Jersey wire cloth. JOHN A. ROEBLING'S SONS CO. *Pit & Quarry*, **22** [9], 71 (1931).—This loose-leaf catalogue describes and illustrates a complete line of wire cloth for screening purposes. It contains Bureau of Standards specifications for sieves. E.P.R.

Automatic Filtering Apparatus. (Selbsttätige Filtrationsapparate.) J. V. DUBSKÝ. iv + 32 pp. G. Thieme, Leipzig, 1931. Price 3M. As the title indicates, this booklet deals with the construction and use of various types of automatic filtering apparatus for use in research and technical laboratories. D. has summarized all the available literature on the subject and the list of 70 references will be of great value. The numerous clearly printed diagrams are helpful, and any chemist who has to deal with the problem of arranging for a self-regulated filtering apparatus will find this work of considerable value. (*B.C.A.*)

Crushing and Grinding. ANON. *Refrac. Jour.*, **7** [7], 346 (1931).—This new monthly journal is devoted to processes and machinery for the trades, industries, and professions connected with crushing and grinding of ores and metals and colloidal grinding. It is published by the Electrical Press, Ltd. E.P.R.

Patterson pebble mills. PATTERSON FOUNDRY & MACHINE CO. *Pit & Quarry*, **22** [8], 71 (1931).—This booklet describes and illustrates a line of pebble mills. It contains specification tables and illustrations showing details of the features of these mills. E.P.R.

PATENTS

Chromium plating. ERWIN SOHN AND RALPH J. PADDOCK. U. S. 1,815,081, July 21, 1931. The process of chromium plating which comprises passing an electric current through a bath containing from 150 to 450 g. of chromic acid, from 0.35 to 1.05 g. of sulphuric acid, and from 0.3 to 3.0 g. per liter of hydrofluosilicic acid to the article to be plated as cathode.

Brick mold-rapping mechanism. CLAYTON POTTS AND WILLIAM S. MINTER. U. S. 1,815,583, July 21, 1931. In a mold-rapping device, a table adapted to carry molds thereon, mold-arresting means, a hammer on each side of the table movable in relation thereto, means normally moving the hammers toward the table, means overcoming the first means for holding the hammers outwardly from the table, and actuating means alternately releasing the hammers from the second means to strike the molds and knock them in alternate opposite directions against one of the arresting means.

Drier control. CLAYTON D. DE MERS. U. S. 1,815,648, July 21, 1931. In apparatus, the combination with a treater chamber of a conduit extending along the outer wall of the chamber, a plurality of tubular connections between the interior of the treater chamber and the conduit, means at one end of the conduit for maintaining a stream of conditioned air therethrough, and means at the other end for determining variations in the moisture content of the stream, the relation of the tubular connections to the conduit being such as to withdraw sample streams from the treater atmosphere.

Brickmaking machine. TWOLIK R. LARGURA. U. S. 1,816,572, July 28, 1931. In a brickmaking machine a die, a die-holding block upon which the die is axially supported, a concentrator member for coöperation with the die in guiding the plastic brickmaking material thereinto, and means to support the outer marginal portions of the member against the outer marginal portions of the die-holding block for distributing forces in the latter remote from the die.

Molding granular mixtures. SEMMEON M. MCANULTY. U. S. 1,818,234, Aug. 11, 1931. A machine for molding by jolting, comprising a mold, means for jolting the mold, a follower operating against the material in the mold, and means for applying fluid pressure to the follower.

Dust arrester. RAYMOND H. MOORE. U. S. 1,818,736, Aug. 11, 1931. In a dust arrester, the combination of a casing provided with an air inlet and an air outlet, a series of screen units each comprising a frame and fabric sides, a flanged bar at the top of the casing, blocks fixed in the upper front corners of the frames, bolts passing through the blocks and flange to secure removably the frames to the bar, and means for removably securing the lower front corners of the frame in the casing.

Continuous preparation of kaolin and clay products. E. MÜLLER. Brit. 352,036, July 15, 1931.

Apparatus for drying clayware, etc. W. W. TRIGGS. Brit. 352,381, July 22, 1931.

Differential apparatus for measuring the expansion of rods due to heat. SOC. ANON. DE COMMENTRY, FOURCHAMBAULT, ET DECAZEVILLE. Ger. 520,612, July 2, 1925. Details of construction and arrangement are given. (*C.A.*)

Canal drier for ceramic ware, etc. HERMANN HAAS. Ger. 521,777, July 1, 1928. (*C.A.*)

Kilns, Furnaces, Fuels, and Combustion

Technical heat control measurements in chamber kilns. W. LIESEGANG. *Ber. deut. keram. Ges.*, **12** [4], 187 (1931).—Temperature measurements were made in a coal-fired chamber kiln having but one chamber by means of thermoelectric pyrometers for the lower temperature and ardometers for the high temperature. Apparatus is listed for

measuring the temperature of kilns having more than one chamber. To get perfect supervision it is also necessary to control the gas pipe and the heat channel. A special automatic temperature regulator which was developed by the Siemens Co. is described. Advantages of an automatic firing system are given. Illustrated. See following abstract; see also *Ceram. Abs.*, **10** [3], 214 (1931). I.R.

Measuring technique in round kilns for heavy ceramic ware. W. LIESEGANG. *Feuerfest*, **7** [6], 94 (1931); for abstract see *Ceram. Abs.*, **10** [6], 450 (1931). M.V.K.

Heating ceramic kilns with smoke gases and electric heaters. PORZELLANFABRIK KAHLA. *Feuerfest*, **7** [6], 90 (1931); for abstract see *Ceram. Abs.*, **10** [5], 379 (1931). M.V.K.

Coreless induction furnace in the steel industry. E. F. NORTHRUP. *Iron Steel Eng.*, **8**, 210–15 (1931).—Inductive electric heating is more versatile in application than are other electric methods of heating. It is superior to any other known method for the direct conversion of electric energy into useful heat. Several typical and representative installations are briefly discussed. The lines of commercial development of coreless inductive heating are listed as (1) more and larger ferrous-metal melting furnaces, gradually displacing the arc-furnace melting; (2) heating to forging temperature of symmetrically shaped ferrous-metal bodies in increasing quantities and the maintaining of temperature in hot steel billets as pushed from the molds to replace the soaking pit; (3) heating to an annealing temperature stacked piles of thin sheet steel; (4) heating for annealing purposes or normalizing continuously moving metal strip and rods; (5) heating with temperature control and great uniformity large muffle annealing furnaces; (6) extension of inductive heating with small furnaces supplied with high-frequency power for all varieties of scientific investigation where freedom from contamination of the charge is essential and where the temperatures that may be reached will meet all scientific requirements; (7) the production on a large scale of high-temperature heaters for such purposes as the graphitization of coke; and (8) the construction and use of multiple-ton furnace ladles which will maintain the metal at a constant temperature and electrically stir this metal to any desired degree for refining it under slags. (*C.A.*)

Possibilities of the electric furnace. PAUL MARTHOUREY. *Rev. métal.*, **28**, 101–16, 139–50 (1931).—A general survey is given of the arc electric furnace, development of the arc electric furnace in the entire world, particular possibilities, and better control of operation. (*C.A.*)

"Universal" kiln and its operation. E. GROSSKINSKY. *Ziegelwelt*, **62**, 152 (1931).—The kiln is of the annular type and takes the form of a truncated "T." The "corners" formed by the T form two separate 3-chambered kilns so that the whole kiln is rectangular in shape and consists of three units. Each unit can be fired separately or together with one or both of the others. The kiln was developed to overcome the difficulties associated with the firing of clinkers in periodic kilns without excessive coal consumption and with the continuous firing of porous brick in ordinary annular kilns. The kiln is said to be readily adaptable to the drying and firing of other products, even foodstuffs. (*Trans. Ceram. Soc.* [Eng.])

Zigzag kiln for roofing tile. H. DENDL. *Deut. Ziegel-Ztg.*, p. 325 (1931); for abstract see *Ceram. Abs.*, **10** [9], 655 (1931). (*Trans. Ceram. Soc.* [Eng.])

Calculation of regenerators. KURT RUMMEL. *Arch. Eisenhüttenwesen*, **4**, 367–74 (1931); for abstract see *Ceram. Abs.*, **10** [8], 593 (1931). (*C.A.*)

Firing porcelain in tunnel kilns. HENTSCHEL. *Gas Wasserfach*, **74** [23], 549 (1931); *Feuerungstechnik*, **19** [7], 119 (1931).—Firing porcelain in a Faugeron tunnel kiln with direct coal or gas firing in the porcelain plant of C. Tielsch & Co. in Altwasser is described. M.V.K.

Heat in Hoffman kilns and tunnel kilns. L. D. *Rev. mat. constr. trav. pub.*, No. 260, p. 90*F* (1931).—Less fuel is required for a tunnel kiln than for a Hoffman kiln or one of similar type because there is less loss of heat through radiation, absorption by masonry, and through the cooling of the fired brick. M.Y.H.

Action of ash on refractory masonry. E. STEINHOFF. *Arch. Wärmewirt.*, **12** [3], 74–76 (1931); *Feuerfest*, **7** [6], 92 (1931).—The possibilities of solving the difficulties connected with the use of coal-dust firing in ceramic industries, especially the action of the cinders on the walls of the firing chamber are discussed. M.V.K.

Dust elimination from chimney gases. ANON. *Mech. World*, **90** [2323], 30–32 (1931).—During recent years considerable advance has been made in the operation of power stations, steam-boiler plants in general, and the obtaining of dust-free chimney gases. The elimination of dust from chimney gas is of interest since similar methods are being adopted for dealing with all kinds of dust. Much attention has been given to the dust problem by Davidson & Co., Ltd., Sirocco Engineering Works, Belfast, and as a result of its investigations during the last 6 years it is claimed that 70 to 95% of the dust in combustion gases can now be separated, in spite of the fact that each ton of coal produces about 500,000 cu. ft. of gas. E.P.R.

Automatic temperature regulators. S. HELD. *Chaleur ind.*, **12**, 203–10, 289–98 (1931).—The theory is explained. A.J.M.

Study of thermal problems. W. MARGOULIS. *Chaleur ind.*, **12**, 269–77 (1931).—The theory of heat transmission by convection is explained. A.J.M.

Electrical heating and the rational utilization of energy. R. DUPUY. *Chaleur ind.*, **12**, 313–20 (1931).—D. discusses the methods of utilizing energy. A.J.M.

Importance of temperature control in the manufacture of ceramic products. I. P. O. HEBLER. *Fuels & Fur.*, **9** [2], 217–23 (1931).—H. gives a table of the various ceramic commodities fired at high temperatures. Diagrams show the method of installing thermocouples in various types of kilns. Satisfactory ware may be produced in a kiln where pyrometer- and gas-analysis equipment are not used and a few weeks later, under supposedly the same firing conditions, broken or spoiled ware in excess of the allowable limit will be produced. With a pyrometer, the kiln can be regulated and where duplication is desired charts can be referred to in order to obtain it. The same applies where uniformity of color is desired. Care must be taken to protect the thermocouple against corrosion and contamination. It is also necessary to check up periodically, on the accuracy of the thermocouples. In a number of plants CO_2 recorders, which may be used as a direct indication of a reducing, oxidizing, or neutral atmosphere, play an important part in firing processes. A.E.R.W.

Small pulverizer for grinding dry or wet coal. ANON. *Pit & Quarry*, **22** [8], 75–76 (1931).—The economical use of pulverized coal by small industrial boiler plants requires a coal pulverizer having the same relative performance and reliability of the higher capacity pulverizers. The design of such a pulverizer is described. E.P.R.

Coal testing. A. B. OWLES. *Elec. Rev.*, **109** [2800], 125–26 (1931).—Every power station should have a well-equipped chemical laboratory under the control of experienced chemists for the sampling and preparation of fuel for analysis and the determination of its average calorific value. The sampling and testing of coal has become an established practice in large power stations. O. has been working on the problem for over two years, and the B.E.S.A. has recently issued two important booklets, *viz.*, "Sampling and Analysis of Coal for Export" (see *Ceram. Abs.*, **10** [4], 292 (1931)) and a report by E. S. Grumell and A. C. Dunningham on "The Sampling of Small Coal up to Three Inches in Size." A British Standard Specification for inland purposes (B.S.S., No. 42–1931), applicable to power-station sampling, is now available (*Ceram. Abs.*, **10** [1], 59 (1931). E.P.R.

Pulverized fuel firing at mines. ANON. *Queensland Mining Jour.*, **32** [6], 234 (1931).—One of the most notable achievements in the field of fuel technology is the advance that is being made with the "unit" pulverizer in competition with the "bin and feeder" system and mechanical stoking. The accumulation of small low-grade slack and fine coal separated in the dry-cleaning processes (which is particularly suitable for pulverized-fuel firing) is rapidly increasing. See also *Ceram. Abs.*, **10** [5], 371, 377 (1931). E.P.R.

Oil from coal. E. D. CROFT. *Mech. World*, **90** [2325], 75 (1931).—At suitable temperatures and pressures the treatment of coal with hydrogen results in the conversion of a considerable proportion of the coal substance into distillable oils. The process consists of two parts: (1) the production of hydrogen in a moderate state of purity cheaply, and (2) the actual hydrogenation of the coal. This work is being carried out experimentally by the Fuel Research Board, initiated by the Department of Scientific and Industrial Research. Retorts are filled with iron oxide, deposited in a finely divided state on pumice stone, and water gas is passed through the retorts. The iron oxide (Fe_3O_4) is reduced either to iron or to the oxide (FeO) and steam is then passed over the iron or reduced oxide to give hydrogen and the oxide (Fe_3O_4). At present the plant in use has an output of 1800 cu. ft. of hydrogen an hour, and an average purity of 97 to 98%. The second stage of the process is the treatment of the coal with hydrogen. The reaction must be carried out at the relatively high temperature of 450 °C combined with the high pressure of 200 atmospheres. The coal is first mixed into a stiff paste with a suitable oil or tar, usually a fraction of the liquid product of a previous experiment, and a small amount of iron oxide is added to remove any traces of sulphur. E.P.R.

Oil from Queensland coal. ANON. *Queensland Mining Jour.*, **32** [6], 217 (1931).—The Queensland Mines Dept. is carefully watching advances in the production of oil from coal by low-temperature carbonization and by hydrogenation. The proof of the commercial practicability of any process will be welcomed. E.P.R.

Mechanism of the combustion of powdered coal. A. GREBEL. *Chaleur ind.*, **12**, 221–32 (1931).—The treatment is theoretical and mathematical. See also *Ceram. Abs.*, **10** [9], 657 (1931). A.J.M.

Conservation of coal. C. LANGE. *Rev. mat. constr. trav. pub.*, No. 260, pp. 205–208 (1931); for abstract see *Ceram. Abs.*, **9** [9], 771 (1930). M.Y.H.

Combustion in theory and practice. H. L. KAUFFMAN. *Rev. mat. constr. trav. pub.*, No. 260, p. 208 (1931); for abstract see *Ceram. Abs.*, **9** [8], 667 (1930). M.Y.H.

Progress in pulverized-coal installation. ANON. *Mech. World*, **90** [2322], 5 (1931). E.P.R.

Recirculation of flue gas in industrial furnaces. C. W. STORT. *Feuerungstechnik*, **19** [7], 105–10 (1931).—Recirculation is the term applied to that method of firing in which the flue gases (products of combustion) or a part of them are withdrawn at a place behind the zone of highest temperature and are re-added to the fire gases, air of combustion, or fuel in another place in front of this zone. The application of this type of firing to furnaces in different industries is explained. It is especially advantageous in ceramic kilns for obtaining a long uniform flame in the kiln and equal distribution of heat over the entire charge. M.V.K.

Method for determining gas velocities. F. BÖSSNER. *Z. Oesterr. Ver. Gas Wasserfach.*, **70** [9], 140–42 (1930); *Instrument World*, **3**, 289 (1931); for abstract see *Ceram. Abs.*, **10** [3], 216 (1931). H.H.S.

Factors to consider in buying fuel oil. ANON. *Brick Clay Rec.*, **79** [1], 32 (1931).—The properties of fuel oil in the order of their importance to the ceramic manufacturer are (1) viscosity, (2) sulphur, (3) pour point, (4) B.t.u. content, (5) method of manufacture, and (6) bottom settlings and water. E.J.V.

BOOKS AND BULLETINS

Technical Fuel Practice. (Brennstofftechnisches Praktikum.) M. DOLCH. Wilhelm Knapp, Halle, Germany. 148 pp. Price 8.80 Rm unbound, 9.80 Rm bound. *Colliery Guard.*, **142** [3680], 124 (1931); *Gas Jour.*, **195** [3554], 24 (1931).—In this book on fuel analysis, the largest section is devoted to the laboratory assay of coals from the point of view of ascertaining the yields of carbonization products. The German methods based on the use of the aluminum retort and the V_2A steel retort for low and high temperatures, respectively, are described, as is also an apparatus for the study of the effect of increased cracking of the carbonization gases. Incidental determinations such as the analysis of gases and tar and the determination of the specific gravity and calorific value of gases are described with special reference to these assay tests. E.J.V.

Industrial Furnaces. (Les fours industriels.) **Vol. I.** W. TRINKS. Translated into French by A. Schubert. Published by Dunod, Paris. 365 pp. Reviewed in *Chaleur ind.*, **12,** 266 (1931). A.J.M.

Power and Fuel Bulletin. WORLD POWER CONFERENCE. British National Committee, London, 1931. Price $2.75 per annum. Great Britain, Japan, Germany, and the U.S. are each publishing monthly bulletins prepared by their national committees of the World Conference. The information will be grouped under the headings (*a*) sources, (*b*) generation, (*c*) distribution and storage, and (*d*) utilization. H.H.S.

Relationship between oxidizability and composition of coal. WILFRID FRANCIS AND H. M. MORRIS. Bur Mines, *Bull.*, No. 340, 44 pp., 5 illus. Price 10¢. Tests of a series of coals of widely different rank are discussed and results are tabulated. R.A.H.

PATENTS

Return baffle for flue doors. FREDRIK W. HVOSLEF. U. S. 1,817,150, Aug. 4, 1931. A baffle for flue doors comprising a plate having means for attaching it to and spacing it from the inner side of a flue door, the plate being of curved form for deflecting flue gases from one flue to another.

Separating and utilizing constituents of natural gas. JOSEPH S. BELT. U. S. 1,817,908, Aug. 11, 1931. In the process of separating and utilizing constituents of natural gas, the improved steps which consist in first burning the natural gas with oxygen in an air-tight chamber to produce flue gases in which the hydrocarbon compounds in the natural gas have been converted to carbon dioxide and water vapor, condensing and removing the water vapor from the flue gases, and then solidifying and removing the carbon dioxide from the flue gases to recover the inert gases therefrom.

Pulverized-fuel burner. L. V. ANDREWS AND OLLISON CRAIG. U. S. 1,817,911, Aug. 11, 1931. A burner for pulverized fuel comprising a central imperforate fuel pipe mounted adjacent to a furnace and arranged to discharge into the furnace a stream of pulverized fuel and primary air, means including a series of deflectors arranged uniformly around the pipe to direct a whirling stream of secondary air into the furnace, an annular orifice plate mounted within the pipe and spaced from its discharge end to present a narrow deflecting surface in the path of any segregated fuel traveling along the pipe wall, and a spreading device adjacent to the discharge end of the pipe and arranged to whirl the fuel stream and throw it outwardly into the secondary air.

Electric heating appliance. JOHN A. BOYER. U. S. 1,818,191, Aug. 11, 1931. In an electric-heating device, the combination of a rigid resistor and terminal members having contact surfaces, of an aluminum base alloy containing some aluminum in the free state and having an incipient melting point substantially the same as the melting point of pure aluminum and a temperature of complete melting at least 300°C above the melting point of pure aluminum.

Oil vaporizer and converter. CORNELIUS B. WATSON AND AUDLEY E. HARNSBERGER. U. S. 1,818,512, Aug. 11, 1931. In an oil heater, a furnace including a setting, a bridge wall situated within the setting dividing the latter into primary and secondary chambers, a burner situated within the setting to effect substantially upward movement of the furnace gases through the primary chamber and downward movement of such gases in the secondary chamber, there being a gas outlet provided in communicating relationship with the lower part of the secondary chamber, a horizontal row of heat-absorbing tubes arranged openly in the primary chamber, the tubes being spaced from the roof of the chamber and supported by the upper portion of the bridge wall, a communicating second bank of tubes arranged in the secondary chamber, and means for effecting travel of the oil and oil vapor through the bank of tubes in the secondary chamber in a direction substantially parallel or concurrent with the flow of furnace gases through the secondary chamber.

Tunnel kilns. WOODALL-DUCKHAM, LTD., AND A. M. DUCKHAM. Brit. 353,086, July 29, 1931.

Annular and zigzag kilns heated with coal dust. FRANZ MÜLLER. Ger. 503,326, July 23, 1930; *Feuerfest*, **7** [6], 89 (1931).—The fire chambers open out on the lower part of the charge and extend deep into the masonry. The burners are in the outer front end of the long fire chambers lying at right angles to the firing channel. A gradual combustion of the coal dust is thus made possible. Overheating of the fire chamber and the charge is prevented and the ashes are gradually deposited in solid form in the fire chambers. The latter can lie wholly or partly inclined in the direction of the draft and be shut off by a damper for the purpose of regulating the supply of additional air. M.V.K.

Tunnel kiln for earthenware. RUDOLF SCHNEIDER. Ger. 519,610, Oct. 26, 1928. The kiln has latticed partitions. (*C.A.*)

Tunnel kiln. KARL BUHLMANN. Ger. 519,874, July 16, 1930. Details of packing the shell walls with granular material are given. (*C.A.*)

Kiln for firing brick, chamotte, or porcelain. C. H. WECK, KOMM.-GES. Ger. 519,875, Jan. 13, 1929. Details of charging are given. (*C.A.*)

Annular chamber kiln with grate. BORNKESSEL & CO. M. B. H. Ger. 523,245, April 21, 1927. (*C.A.*)

Annular kiln for brick, etc. GUGLIELMO PIPERNO AND ADOLFO CARENA. Ger. 524,070, Nov. 12, 1929. (*C.A.*)

Cooling ceramic articles, etc., in tunnel kilns. HOLDING-GES. FÜR KERAMISCHE WERTE. Ger. 524,247, Oct. 9, 1929. A method of regulating the cooling is described. (*C.A.*)

Geology

Appalachian structural front. PAUL H. PRICE. *Jour. Geol.*, **39** [1], 24–44 (1931).—The Appalachian structural front marks a comparatively narrow zone, east of which the rocks have been greatly mashed, folded, and faulted, while west of this zone the rocks lie more nearly horizontal. This is shown by cross-sections. The structural break closely parallels the axis of the trough of deposition from at least early Silurian to the close of Pottsville time and therefore follows an inherited line of weakness. The type of failure was governed by the shape of the basin and the character of the beds, whether competent or incompetent, and their position in the stratigraphic section. G.R.S.

Adirondack magmatic stem. A. F. BUDDINGTON. *Jour. Geol.*, **39** [3], 240–63 (1931).—The intrusive rocks of the Adirondacks vary from anorthosite and gabbro

through various syenitic and granosyenitic types to granite. The problem of the origin of the anorthosites is considered. A study of the rocks of the Adirondack series and comparisons with other rock stems are made. G.R.S.

Structure section across the Canadian Rockies. P. E. RAYMOND. *Jour. Geol.*, **39** [2], 97–116 (1931).—The section of the Canadian Rockies along the line of the Canadian Pacific Railway is described with a brief résumé of the geological history of the region. G.R.S.

Anorthosite in Los Angeles County, California. W. J. MILLER. *Jour. Geol.*, **39** [4], 331–44 (1931).—A description and an explanation are given of a large occurrence of anorthosite in Los Angeles County, California. Several theories of the origin of anorthosite advocated by petrologists are considered in their application to the occurrence, and comparisons are made with anorthosites of other regions. G.R.S.

Stratigraphy of the Ordovician Hounsfield metabentonite. G. M. KAY. *Jour. Geol.*, **39** [4], 361–76 (1931).—The Hounsfield metabentonite, an altered volcanic ash of Ordovician Black River age, lying above the Leray and below the Watertown members of the Chaumont formation at its type section in New York, has been identified in sections in N. Y., Ont., Wis., Iowa, Minn., Mo., Ky., and Tenn. Stratigraphic sections are described from several regions and the criteria supporting the identification of the beds with the type Hounsfield are summarized. G.R.S.

Deposits of diatomaceous earth. ANON. *Econ. Rev. Soviet Union*, **6** [13], 311 (1931).—Deposits of diatomaceous earth estimated at about 300,000 tons were recently discovered in the Devil's Swamp near Kingisepp (Leningrad Region). M.V.K.

Peorian loess and the classification of the glacial drift sheets of the Mississippi valley. M. M. LEIGHTON. *Jour. Geol.*, **39** [1], 45–53 (1931).—Peorian time is recorded primarily by the loess deposit and the time was so short that the Iowan ice invasion is regarded as the first of the series of invasions of the Wisconsin glacial epoch. This permits, on the one hand, a natural classification of the Wisconsin stage, according to ice centers, and, on the other, a subdivision of Pleistocene time in America that harmonizes with the subdivisions of Europe. See also *Ceram. Abs.*, **9** [12], 1090 (1930). G.R.S.

Geology and use of diatomite in modern industry. ANON. *Pit & Quarry*, **22** [8], 79 (1931).—Common names for diatomite are diatomaceous earth, tripoli, kieselguhr, and infusorial earth. More than 10,000 varieties of diatoms have been studied and classified. The more important uses are (1) filtration medium, (2) heat insulation material, and (3) admixture in concrete. E.P.R.

Producing potash by calcining polyhalite. ANON. *Rock Prod.*, **34** [15], 69 (1931).—Investigations at the Bureau of Mines Nonmetallic Minerals Experiment Station have shown calcination to be a necessary first step in the extraction of potash from polyhalite. Some figures on the operation are presented. See also *Ceram. Abs.*, **9** [9], 781; [10], 886 (1931). W.W.M.

Determination of the structure of analcite. W. HARTWIG. *Z. Krist.*, **78** [3–4], 173–207 (1931).—Analcite was studied by means of photographs of rotating powdered material. The film showed a space-centered cubic lattice with cubic edge of 13,684 ± 0.02 Å. The unit cell contains 16 molecules of $NaAlSi_2O_6 \cdot H_2O$. The density was 2.267. The cubic space grouping was O_h^{10}. G.R.S.

Deformation of crystals at high pressures and high temperatures. F. HEIDE. *Z. Krist.*, **78** [3–4], 257–78 (1931).—Pressure studies made on the minerals barite, celestite, and calcite showed that high temperatures can influence the ability of crystals to undergo translation and simple gliding. At 400° barite shows the ability to translate to (001), (011), (102), (010) and ?(110), and the simple gliding with K_1 = (110), K_2 = (110). Celestite shows under analogous research restrictions, the ability of translation

to (001), (011), (102), ?(110) and gliding of the same scheme as barite. Translation to (010) could not be observed. In the case of calcite similarly studied, the ability of translation to (001), (011), and also to (102) and ?(110) was found with gliding similar to that observed with the other minerals. At room temperature and high pressures up to 17,000 atmosphere, all three minerals exhibited only translations to (001) and (011). G.R.S.

Further studies in the amphibole group. A. N. WINCHELL. *Amer. Mineralogist*, **16** [6], 250–66 (1931).—The following series are discussed: (1) anthophyllite, (2) cummingtonite, (3) tremolite-acetinolite, (4) $H_2Ca_2Mg_5Si_8O_{24}$–$H_2NaCa_2Mg_5AlSi_7O_{24}$, and (5) common hornblende. The relations between composition and optic properties in all of these series are shown in five diagrams. References for each figure are given. G.R.S.

Classification of igneous rock series. M. A. PEACOCK. *Jour. Geol.*, **39** [1], 54–67 (1931).—Some rock series cannot be properly classified either as alkalic or as subalkalic. Therefore, the fourfold division alkalic, alkali-calcic, calc-alkalic, and calcic groups, is proposed. The silica value at which the curves for total alkalis and for lime intersect (the alkali-lime index) is characteristic and is of classificatory value. Limits are suggested for the proposed four groups in terms of the alkali-lime index and of characteristic minerals. Other classifications of rock series are briefly noticed. G.R.S.

Imperial Geophysical Survey in Australia. T. W. EDGEWORTH DAVID. *Jour. Council Sci. & Ind. Research* [Australia], **4**, 107–18 (1931).—Australia was chosen as the special part of the Empire where geophysical methods of prospecting should be tried under government auspices. During operations a considerable body of data was collected on the various methods. It was found that corresponding to each method there are geological conditions under which it operates most successfully. The seismic, magnetic, and electrical methods are much more rapid than the gravimetric. Careful geological survey should precede geophysical survey. H.H.S.

Geology of dolomite. II. W. MORITZ. *Tonind.-Ztg.*, **55** [47], 684–85 (1931).—Further hypotheses on the formation of dolomite are given. For Part I see *Ceram. Abs.*, **10** [9], 659 (1931). W.M.C.

Natural silicates and pozzuolanas of the Canary Islands. T. GASPER Y ARNAL. *Chim. Ind.*, **25**, 1064 (1931). (*Trans. Ceram. Soc.* [Eng.])

BOOKS AND BULLETINS

Science of the Structure of Rocks. (Gefugekunde der Gesteine.) BRUNO SANDER. Julius Springer, Wien, 1930. 352 pp. 37.60 M unbound, 39.60 M bound. Reviewed in *Jour. Geol.*, **39** [4], 397 (1931).—This book takes up some of the mathematical and physical aspects of structural geology in a manner not yet attempted in an English publication. Structural relations of single minerals are studied. Some are more resistant to deformation than others and an attempt is made to evaluate these differences and to carry them over into rock types. The rotation of individual mineral grains in the production of structures has been investigated and it is shown that some grains change position with almost no internal deformation while their neighbors are considerably deformed. Illustrated. G.R.S.

Geology and Mineral Resources of Kentucky. W. R. JILLSON. *Ky. Geol. Surv.*, Series VI, Vol. XVII, 409 pp. (1928); reviewed in *Jour. Geol.*, **39** [2], 188–89 (1931).—This is a nontechnical discussion by counties and it consists of a brief review of the previous knowledge of each unit, covering the physiography, stratigraphy, mineral resources, economic geology, etc. The illustrations are clear and well selected. G.R.S.

The Mineral Industry of the Far East. BORIS P. TORGASHEFF. The Chali Co., Ltd., Shanghai, 1930. 500 pp. $10.00. Reviewed in *Jour. Geol.*, **39** [2], 170 (1931).—

This is a comprehensive report on the mineral resources and mining prospects of China, Manchuria, Mongolia, Japan, Korea, Formosa, Russian Far East, the Philippines, and Indo-China. Its usefulness is increased by maps and a complete bibliography. G.R.S.

Tables for the Determination of Minerals by Means of Their Physical Properties, Occurrences, and Associates. E. H. KRAUSS AND W. F. HUNT. Reviewed in *Jour. Geol.*, **39** [2], 189 (1931); for abstract see *Ceram. Abs.*, **10** [4], 299 (1931). G.R.S.

Guide to the Study of Nonmetallic Mineral Products (Except Building Stones). W. S. BAYLEY. Reviewed in *Jour. Geol.*, **39** [1], 94–95 (1931); for abstract see *Ceram. Abs.*, **9** [10], 879 (1930). G.R.S.

Sixteenth Report of the State Geologist on the Mineral Industries and Geology of Vermont, 1927–1928. GEORGE H. PERKINS. 390 pp. Reviewed in *Jour. Geol.*, **39** [1], 94 (1931).—These thirteen articles form a valuable contribution to general geology as well as to the knowledge of the geology of Vermont. G.R.S.

Detection of the Opaque Minerals. C. M. FARNHAM. 236 pp. McGraw-Hill Co., New York, 1931. Price $3.50. H.H.S.

Minerals in Modern Industry. WALTER H. VOSKUIL. Chapman & Hall, Ltd., London. *Refrac. Jour.*, **7** [7], 330 (1931).—In the preface V. states that his aim has been "to present the fundamental economic facts and characteristics relating to the mineral industry" in the U.S. E.P.R.

Selected Chapters on Geochemistry. (Geochemie in ausgewählten Kapiteln.) W. J. VERNADSKY. Translated from Russian by E. Kordes. 370 pp. 25 M bound, 23 M unbound. Reviewed in *Jour. Geol.*, **39** [2], 186–87 (1931).—This book is unusual in geochemical literature as it deals with chemical processes exclusive of those which operate principally in ore deposits and it approaches them from the chemical rather than the geological standpoint. The larger part of this book is devoted to the discussion of silicate rocks, their weathering, and the products of this weathering such as free silica, kaolin, bauxite, and clays. Surprisingly little reference is made to specific localities. In fact V. deals largely in generalities. G.R.S.

Geology from Original Sources. W. M. AGAR, R. F. FLINT, AND C. R. LONGWELL. Henry Holt and Co., New York, 1929. 527 pp. $3.75. Reviewed in *Jour. Geol.*, **39** [2], 187 (1931).—The book is a reference text for elementary students in geology presenting in convenient and interesting form the better portions of geologic literature. G.R.S.

A Textbook of Geology. Part I. Physical. L. V. PRISSON AND CHARLES SCHUCHERT. John Wiley and Sons, New York, 1929. 488 pp. Price $3.75. Reviewed in *Jour. Geol.*, **39** [1], 87–89 (1931). G.R.S.

Engineering Geology. (Ingenieurgeologie.) K. A. REDLICH, K. v. TERZAGHI, AND R. KAMPE. 707 pp. Reviewed in *Jour. Geol.*, **39** [4], 397 (1931); for abstract see *Ceram. Abs.*, **9** [7], 575 (1930). G.R.S.

Introductory Economic Geology. W. A. TARR. 664 pp. $5.00. Reviewed in *Jour. Geol.*, **39** [1], 92–94 (1931); for abstract see *Ceram. Abs.*, **10** [2], 143 (1931). G.R.S.

Elementary Economic Geology. H. RIES. Reviewed in *Jour. Geol.*, **39** [3], 301–303 (1931); see also *Ceram. Abs.*, **10** [9], 660 (1931). G.R.S.

Physical Properties of the Soil. B. A. KEEN. Reviewed in *Soil Sci.*, **32** [1], 71 (1931); see also *Ceram. Abs.*, **10** [9], 666 (1931). G.R.S.

The Major Soil Divisions of the United States. G. A. WOLFANGER. John Wiley & Sons, 1930. 150 pp. Reviewed in *Jour. Geol.*, **39** [1], 91–92 (1931).—This book is a radical presentation of the anti-geological viewpoint. It emphasizes the influence of environment and minimizes the influence of the source of the soil. G.R.S.

Pre-Illinoian Pleistocene Geology of Iowa. GEORGE F. KAY AND EARL T. APFEL. *Iowa Geol. Surv.*, Vol. 34. Des Moines, Iowa, 1929. 289 pp. Reviewed in *Jour. Geol.*, **39** [1], 84–86 (1931).—The authors present the results of their extended field and laboratory studies of the older glacial and intergiacial deposits of Iowa, together with a map of the drift sheets which, for the first time, show the approximate distribution of the Nebraskan drift where overlying deposits, excepting loess and alluvium, have been cut away. G.R.S.

The Pleistocene of Northern Kentucky. FRANK LEVERETT. *Ky. Geol. Surv.*, Series VI. Reviewed in *Jour. Geol.*, **39** [2], 186 (1931).—This bulletin contains five papers: the one designated by the title (81 pp); "The climate of Kentucky," by S. S. VISCHER (88 pp); "Geology of the southern part of the Dawson Springs of Trigg, Lyon, and Livingston Counties, Kentucky," by J. K. ROBERTS (56 pp.); and "The geology and physiography of the Mammouth Cave National Park," by A. K. LOBECK (74 pp.). See also *Ceram. Abs.*, **9** [9], 781 (1930). G.R.S.

Geologic Map of Arkansas. G. C. BRANNER. Issued by the Arkansas Geological Survey in coöperation with the U. S. Geological Survey. Price, $1.80 postpaid. Reviewed in *Jour. Geol.*, **39** [4], 399 (1931).—The map is of unusual merit due to its arrangement and introduction of new features. Economic data such as mines, quarries, oil and gas fields, pipe lines, etc., the axes of the anticlines in the Arkansas River Valley province, and the physiographic divisions of the state shown upon a small scale map in the legend add to its usefulness without detracting from its general appearance. Separate geologic columns with the corresponding symbols for the formations are given for the major divisions of the state, thus permitting great detail in each case. G.R.S.

Topographic and Geologic Atlas of Pennsylvania. New Castle Quadrangle No. 5. F. W. DE WOLF. **Pittsburgh Quadrangle No. 27.** MEREDITH E. JOHNSON. 238 pp. Reviewed in *Jour. Geol.*, **39** [2], 190 (1931).—In both quadrangles the stratigraphy of the coal measures is considered in detail. Economic resources consist principally of coal, natural gas, and petroleum. An appendix is given showing detailed sections of forty-four diamond-drill holes in the Pittsburgh quadrangle. G.R.S.

Glacial Geology and Geographic Conditions of the Lower Mohawk Valley. A. P. BRIGHAM. N. Y. State Museum, *Bull.*, No. 280, 133 pp. (1929). Reviewed in *Jour. Geol.*, **39** [2], 189–90 (1931).—This study covers four quadrangles, Amsterdam, Fonda, Gloversville, and Broadalbin. A description of the physiography is followed by a discussion of the Mohawk glacier, which is shown to have moved westward. G.R.S.

Thallium. A. V. PETAR. Bur. Mines, *Information Circ.*, No. 6453, 6 pp.; *Amer. Glass Rev.*, **50** [42], 28 (1931).—Thallium is one of the rare metals which has come into commercial use within recent years. Its comparative scarcity, combined with a resemblance to the metal lead, have retarded the development of uses for thallium. Perhaps the earliest commercial use of thallium was as a constituent of optical glass of higher refractive power than similar glasses containing lead. The present report presents information on the history, occurrence, uses, production, and marketing of this metal. R.A.H.

Spectrum Analysis in Mineralogy. A. A. FITCH. *Queensland Mining Jour.*, **32** [6], 252 (1931); see also *Ceram. Abs.*, **10** [9], 666 (1931). E.P.R.

Methods and costs of milling feldspar at the Minpro plant, Tennessee Mineral Products Corp., Spruce Pine, N. C. B. C. BURGESS. Bur. Mines, *Information Circ.*, No. 6488, 22 pp., 13 illus.; *Rock Prod.*, **34** [15], 57–66 (1931); *Pit & Quarry*, **22** [8], 29–38 (1931).—This paper is the first of a series being prepared by the Bureau of Mines

on feldspar milling methods and costs in the various feldspar producing areas in the U.S. It describes not only the latest practices in feldspar grinding, but includes studies of the cost of producing ground feldspar. The latest practices in feldspar milling are described and detailed costs of grinding are included. The cost tabulations presented show operating expenditures only and not total production costs. R.A.H.

Zirconium. E. P. YOUNGMAN. Bur. Mines, *Information Circ.*, Nos. 6455 and 6456. 30 pp. **Part I.** Economic features are discussed and general information is given relative to description, properties, uses, minerals, occurrence, mining and preparation, production, market and prices, importers, producers and dealers, and buyers. **Part II.** In addition to giving a brief discussion of the four or five deposits that so far have proved to be commercial sources of the element, this circular summarizes available data upon other occurrences, including many of scientific interest only, of the two commercial minerals, zircon and baddeleyite, and also data upon some of the minor minerals, such as eudyalite and cryolite. R.A.H.

Mineral Resources of the United States, 1928. I. Metals. 910 pp. $1.50. **II. Nonmetals.** 801 pp. $1.25. R.A.H.

Microscopic determination of the ore minerals. M. N. SHORT. U. S. Geol. Surv., *Bull.*, No. 825, 204 pp., 11 plates, 16 figs. Price 60¢. This is a valuable reference book in microscopic methods of determining ore minerals, including full details of microscopic technique, a discussion of the physical properties of the minerals, a determinative table showing the etch reaction of each mineral to several reagents together with details of color, hardness, etc., and a description of the microchemical methods of qualitative analysis, illustrated with colored plates. S. presents a systematic scheme of microchemical analysis designed to identify in as few operations as possible all the principal elements occurring in ore minerals. This is supplemented by specific tests for the different minerals in which many short cuts are possible. The book contains several indexes and will be of great service to workers in mineralogy. R.A.H.

Index to Geophysical Abstracts Nos. 1 to 20. Compiled by PALMER LARSEN. 38 pp. Bur. Mines, *Information Circ.*, No. 6438.—Indexes of authors, articles, patents, and books are included. R.A.H.

Geophysical Abstracts. XXV and XXVI. F. W. LEE. Bur. Mines, *Information Circ.*, No. 6500, 24 pp.; No. 6511, 26 pp.—Monthly reviews are given of recent articles on the development of geophysical methods of prospecting. For Part XXIV see *Ceram. Abs.*, **10** [8], 599 (1931). R.A.H.

PATENT

Determining the character of ore bodies. JOHN J. JAKOSKY. U. S. 1,818,331, Aug. 11, 1931. The method of determining the location of a fault or break in an ore body which comprises inducing current flow in the ore body by causing the same to cut by a primary electromagnetic field, noting the effect at points removed from the source of the electromagnetic field in a direction lengthwise of the ore body of the secondary electromagnetic field produced by such induced current flow, causing the primary electromagnetic field to have at different times a relatively low frequency and a relatively high frequency, varying the position of the source of the primary field and the point of noting the effect of the secondary field and noting in each case the relative effect of the secondary field for each frequency of primary field, and thus locating a position such that if the source of the primary field and the point of noting the effect of the secondary field are at the same side of such position the secondary field is of noticeable intensity at both high and low frequency, while if the source and point are at opposite sides of such position the secondary field at low frequency is either not noticeable or is of much less intensity than at high frequency.

Chemistry and Physics

Difference in the chemical composition in certain grain-size fractions of some clays. R. RIEKE AND W. JOHNE. *Ber. deut. keram. Ges.*, **12** [5], 203 (1931).—This paper discusses the separation of 10 clays into different grain-size fractions and properties of each fraction. Having determined that Stokes' law does not hold in grain-size fractioning by sedimentation, only three fractions were made from each clay. Chemical analysis was made of each fraction. The finest parts are more or less close to the theoretical composition of the clay substance. Quartz is usually in one certain grain-size fraction if the clay is poor in quartz. In case it is rich in quartz, this mineral is distributed to all the fractions, but is less pronounced in the finest one. Iron oxide increases together with alumina in all fractions and is largest in amount in the finest. For a number of clays the amount of iron oxide (in molecular per cent and applied to alumina) is the same in all fractions and therefore it is supposed that in clay substance alumina might be substituted by iron oxide. A maximum in iron oxide in one certain fraction often corresponds to a minimum in titanium oxide. Fluxes always increase in the finest fraction. The clays and their fractions were fired at 1000, 1100, 1200, and 1300°C. The linear shrinkage and porosity of the samples were determined. The results depend on the grain size, the ratio Al_2O_3:SiO_2, and the content of fluxes. The smaller the grain size and the closer the ratio Al_2O_3:SiO_2 to 1:2, the larger is the shrinkage and the lower is the porosity at a given temperature. The beginning of the sintering depends on the fluxes. FeO is more effective at lower temperatures than CaO and K_2O. Shrinkage and porosity have a parallel development up to a given temperature. After that, shrinkage stops but the porosity decreases further. At a still higher temperature, an expansion occurs which might be due to larger pores or the quartz transformation. The finest fraction usually had the highest shrinkage and the lowest porosity though for 5 clays the porosity of the finest fraction was even higher at 1000 or 1100°C than the average one of the clay at the same temperature. Quartz prevents an early shrinkage. I.R.

Mesh openings and particle sizes. J. ANDERSEN. *Zement*, **20** [10–11], 224–26; 242–45 (1931); *Pit & Quarry*, **22** [8], 69 (1931).—A study was undertaken to replace the measurement of mesh openings in sieve analysis by determination of the average diameter of particles which can pass the sieve when the sieving process is completed. This fraction is called size separation (Kornscheide). Investigation covered (1) pure separation, (2) relation between average mesh opening and size separation of certain sieves, (3) demonstration of sieve analyses, and (4) size separation of sieves with different materials. Fineness curves are much smoother than those based on mesh openings. Relation of size separation to mesh opening is about 0.81 in case of mostly spherical particles and slightly less for particles with sharp edges. E.P.R.

Viscosity and rigidity in suspensions of fine particles. II. Nonaqueous suspensions. C. M. MCDOWELL AND F. L. USHER. *Proc. Roy. Soc.* [London], 131*A* [818], 564–76 (1931).—A theory is advanced based on the existence of a structure of particles in contact and is free from two objections which make the hypothesis of extensive solvation difficult to accept. Experiments are described which provide direct evidence of a close connection between rigidity and the formation of a continuous structure, and between variable viscosity and the formation of loose aggregates. For Part I see *Ceram. Abs.*, **10** [8], 605 (1931). G.R.S.

Decomposition of hydrated sodium borates and constitution of kernite. L. HACKSPILL AND A. P. KIEFFER. *Ann. chim.*, **14** [10], 227–82 (1930); *Chim. & Ind.* [Special No.], 520–21 (March, 1931).—The decomposition was studied by heating the hydrates in a vacuum and measuring the pressure. Dehydration of $Na_2B_4O_7 \cdot 10H_2O$ begins at atmospheric temperature, becoming very rapid at 60° to give the dihydrate. Dehydra-

tion of $Na_2B_4O_7 \cdot 5H_2O$ begins at 120° and gives the dihydrate. In both cases the final $2H_2O$ is given off slowly and continuously, dehydration being complete at about 350°. Kernite (which has a composition corresponding to $Na_2B_4O_7 \cdot 4H_2O$) is stable below 60°; 32% of the H_2O is given off sharply at 60°, another 18% also sharply at 116°, and the remainder gradually up to 400°. These facts might be explained by attributing to kernite the formula, $4Na_2B_4O_7 \cdot 10H_2O \cdot 6Na_2B_4O_7 \cdot 5H_2O \cdot 15Na_2B_4O_7 \cdot 2H_2O$, which seems rather difficult to admit, or by assuming that the 3 hydrates are formed during heating as decomposition products of kernite. Study of other similar phenomena is required to prove or disprove this theory. (*C.A.*)

Determination of true Si in silicon carbide. G. W. CHEESBROUGH. *Chemist Analyst*, **20** [4], 7 (1931).—(1) Fuse an 0.5-g. sample with a mixture of 97.5 g. Na_2CO_3 + 2.5 g. KNO_3, dissolve in 30 cc. HCl (1:1), evaporate, and bake 1 hr. at 110°C, boil with 30 cc. HCl, wash with hot water. Evaporate the filtrate, treat as above, combine the filters, ignite, cool, and weigh. Then add a few drops of H_2SO_4, 5 cc. HF, evaporate, ignite, cool, and weigh. The difference in these two weighings is the total SiO_2. (2) Heat a 0.5-g. sample with H_2SO_4 and HF, ignite, fuse with 5 g. of fusing mixture and continue as in (1). The difference between the two determinations gives SiO_2 present as SiO_2. J.G.T.

Titration of alumina by means of oxychinolinacetate for silicates. G. KRINKE. *Sprechsaal*, **64** [30], 556–57 (1931).—The determination of alumina (without removing silica in the beginning) is explained when using oxychinolinacetate. A sample for valuating is given. See also *Ceram. Abs.*, **9** [12], 1101 (1930). W.M.C.

Presence of calcium sulphate in clays and its relation to pouring. ANGELO CASTIGLIONI. *Industria chimica*, **6**, 15–18 (1931).—The sulphates of Ca as well as of the alkali metals coagulate clay suspensions. Therefore, for clays containing small amounts of these compounds, enough more deflocculants are used to prevent coagulation. For large amounts, it is necessary to remove them by changing them to $BaSO_4$ by the addition of the calculated amounts of $Ba(OH)_2$ or $BaCO_3$. Another method of removing the harmful sulphates is first to wash the clay with a solution containing Na_2CO_3 in amounts equivalent to the $CaSO_4$ present. Laboratory tests have proved this method to be satisfactory. (*C.A.*)

New tests for fluorides. B. KOONE. *Chemist Analyst*, **20** [4], 14–15 (1931).—0.5 g. of alizarin is dissolved in 200 cc. of alcohol. 1.5 g. of $ZrCl_4$ is dissolved in 75 cc. of alcohol. The solutions are mixed, red precipitate allowed to settle, filtered, washed with alcohol, and made up to a volume of 25 cc. with alcohol. 5 cc. of it are added to 100 cc. of water and shaken. A colloidal suspension results. To 2.5 cc. of the solution to be tested, an equal volume of concentrated HCl is added and then 0.5 cc. of the reagent. In the presence of 0.3 mg. of F an immediate change of color is observed; 0.03 to 0.3 mg. of F turns the red reagent yellow in 15 seconds. High concentration of oxalates, phosphates, and sulphates produce misleading colors. In the presence of free halogens $NaHSO_3$ is added before acidification. J.G.T.

Preparation and characterization of dicalcium silicate, tricalcium silicate, and tricalcium aluminate. I. WEYER. *Zement*, **20**, 48–51 (1931); for abstract see *Ceram. Abs.*, **10** [2], 158 (1931). (*C.A.*)

Argillaceous colloids and their applications in ceramics. R. DUBRISAY. *Bull. soc. d'encour.*, **130**, 176–82 (1931).—Suspensions of purified kaolin were treated with solutions of HCl and alkalis in varying concentrations and the conditions of stabilization and flocculation were noted. Considerable variations in the volume of the deposit were observed, depending on whether the suspension was stable or flocculent. A study of the deposits tended to support Le Chatelier's view that clay particles have a lamellar structure. (*B.C.A.*)

Freezing point of platinum. WM. F. ROESER, F. R. CALDWELL, AND H. T. WENSEL. Bur. Stand., *Jour. Research*, **6** [6], 1119–29 (1931); summarized in Bur. Stand., *Tech. News Bull.*, No. 170, p. 65 (1931).—Measurements were made of the ratio of brightness of black bodies maintained at the freezing points of gold and platinum. The black bodies used were hollow inclosures of fused thorium oxide immersed in the molten metals. Observations were made during the freezing of the metals. Two optical pyrometers were used and observations were obtained on two separate lots of pure platinum by three observers. The freezing point was found to be 1773.5°C. R.A.H.

Phase equilibria in the system Cr_2O_3–Al_2O_3. E. N. BUNTING. Bur. Stand., *Jour. Research*, **6** [6], 947–49 (1931); R.P. 317.—A study of the phase equilibria in the Cr_2O_3–Al_2O_3 system has shown these oxides to be completely miscible in the liquid and solid states, with no compound formation. The melting point of Cr_2O_3 has been redetermined to be 2275 ± 25°C. R.A.H.

Conductivity of zircon dioxide. H. SCHWEITZER. *Feuerfest*, **7** [6], 92 (1931); for abstract see *Ceram. Abs.*, **10** [9], 665 (1931). M.V.K.

Modification of glycerol method for determination of free lime. G. E. BESSEY. *Rock Prod.*, **34** [16], 67–68 (1931); for abstract see *Ceram. Abs.*, **10** [4], 304 (1931). W.W.M.

Proportional plasticity numbers of kaolin and clay. H. E. MÜLLER AND WILLY GROSSMANN. *Keramos*, **10** [10–11], 269–75 (1931).—The researches on kaolin and clay by the clearing method and the proportional plasticity numbers calculated from this are of value in the quarrying business in aiding in the detection of the essential changes in the physical properties of practically uniform clay material derived from the elutriated product. At the quarry a uniform quality can be composed with the aid of the proportional plasticity numbers. In this way the plant can guarantee its raw product. The ceramist can use this investigation to calculate the physical composition of a normal paste (parallel with the chemical composition) by the aid of the known proportional plasticity numbers from the raw materials. The steps of the investigation are described. M.V.K.

Determination of small quantities of calcium. N. EVERS. *Analyst*, **56**, 293–98 (1931).—Precipitation as sulphate in presence of alcohol is preferred to the oxalate method. H.H.S.

Lateral chromatic aberration of apochromatic microscope systems. I. C. GARDNER AND F. A. CASE. Bur. Stand., *Jour. Research*, **6** [6], 937–46 (1931); R.P. 316.—Methods are described for the measurement of the lateral chromatic aberration and distortion of microscopic objectives and eyepieces. Measurements have been made on 20 apochromatic microscope objectives of four different makes. The results show that the compensating eyepieces, in general, do not entirely compensate the chromatic aberration of the objectives and that the complete microscope system is usually undercorrected. The bearing of this on the performance of the system in photomicrographic work by a 3-color process and in the direct visual observation of objects is considered in detail. R.A.H.

Some investigations in Röntgen spectra. I. X-ray spark lines. G. B. DEODHAR. *Proc. Roy. Soc.* [London], **131***A* [818], 633–47 (1931).—For SiO_2 compared with the pure element, considerable changes in the spectral structure were found. Various suggestions for the origin of X-ray spark lines were examined. **II. X-ray spectra and chemical combination (sulphur).** *Ibid.*, **131***A* [818], 647–53 (1931).—It is suggested that some X-ray lines may possibly result from electronic transitions within a molecule. **III. Fine structure of K-absorption edge of SiO_2.** *Ibid.*, **131***A* [818], 654–58 (1931).—The fine structure of SiO_2 was photographed and measured by using quartz as the analyzing and absorbing crystal. The results of these measurements are given in two tables. G.R.S.

Lenses and mirrors to make sun heat in new solar furnace. ANON. *Amer. Glass Rev.*, **50** [44], 31–32 (1931).—Temperatures as high as in the sun spots and several times as high as any so far obtained in laboratories are expected to be used in the solar furnace to be erected as part of the new astrophysical laboratory of the California Institute of Technology at Pasadena. The sun's light will pass through 19 lenses, each 2 ft. in diameter and 12 ft. focus. Nineteen mirrors will reflect the beam from each lens to a second lens 7 in. in diameter, finally concentrating the original beam which spreads over a circle 10 ft. in diameter to a spot the size of a little finger nail. At this point the solar temperatures are expected and various substances can be introduced to study their behavior. The light from these substances will be analyzed through the prisms of a powerful spectroscope. E.P.R.

The Waidner-Burgess standard of light. H. T. WENSEL, WM. F. ROESER, L. E. BARBOW, AND F. R. CALDWELL. Bur. Stand., *Jour. Research*, **6** [6], 1103–17 (1931); summarized in Bur. Stand., *Tech. News Bull.*, No. 170, p. 62 (1931).—A source of light sufficiently reproducible to serve as a fundamental photometric reference standard has been obtained by carrying out the original suggestions of Waidner and Burgess to immerse a hollow inclosure in a bath of molten platinum and to make observations during the period of freezing. R.A.H.

Electric gas purification. Influence of the electric wind. R. LADENBURG AND W. TIETZE. *Ann. Physik*, **6**, 581–621 (1930).—A theory is given for the electric gas purification. It is pointed out that with the corona discharge, single points are always formed in which positive and negative gas ions are found. Negative ions are pushed against the walls with high velocities and charge the dust particles. Besides this, the dust particles are moved by the action of the electric wind and thus a combined action of the wind and the electric forces takes place. W.M.C.

Explanation of p_H. C. L. MANTELL. *Metal Cleaning & Finishing*, **3** [7], 541–46 (1931).—A practical explanation of the theory of the dissociation of acids and bases into ions is presented. "Strong" and "weak" acids and bases are discussed and a mathematical definition of p_H is given in some detail. E.J.V.

Solving drying characteristics of clay. H. SPURRIER. *Ceram. Ind.*, **16** [5], 447–52 (1931); for abstract see *Ceram. Abs.*, **10** [9], 651 (1931). W.W.M.

Measuring consistency of glaze slips. E. D. TURNBULL. *Ceram. Ind.*, **17** [2], 116–17 (1931).—T. describes two forms of the plastometer and the Stormer viscometer and their use in measuring the consistency of glaze slips. One of the plastometers was developed by Harrison and the other by Gregory, Rassweiler, and Lampert. T. sums up the comparative advantages of the above instruments and the mobilometer for measuring consistencies of various types of glazes. See also *Ceram. Abs.*, **9** [12], 1073 (1930). W.W.M.

Quantitative microscopic analysis of ceramic materials by planimetric oculars. R. BARTA. *Stavivo*, p. 13 (1930); *Feuerfest*, **7** [6], 88 (1931).—This method of analysis is suitable for ceramics, especially for the quantitative determination of crystalline quartz and feldspar. In fragments of a white ware there were found "skopalite," an isomorphic mixture of $Al_6SiO_46Ca_2CaOCa$ and $Al_2Si_3O_93Na_4AlCl$, and "nepheline" ($CaAlSiO_4$); in a slag brick "pseudowollastonite" ($Ca_3Si_3O_9$) was found. M.V.K.

Ideal curve, fineness modulus, and the new standard specifications. KRISTEN. *Zement*, **20** [16], 366–69 (1931).—A comparison is made of the ideal curve, the curve by Otzen, and Abrams' fineness modulus. The new text of the German standard specifications for reinforced concrete is discussed. The best and most economic way to improve a material is to compare its sieve analysis with the ideal curve (without cement). If it is necessary to add coarse materials, percentages of these additions can be found with fineness modulus by Hummel's method. A graphical method for plotting curves is

explained, especially the conversion of Tyler sieve openings into metric equivalents. See following abstract. (*Jour. Amer. Concrete Inst.*)

Criticism of fineness modulus. A. HUMMEL. *Zement*, **20** [6], 129–34 (1931).—H. discusses investigators' comments on his paper, "The valuation of sieve analyses and the fineness modulus by Abrams" (see *Ceram. Abs.*, **9** [9], 709 (1930); *Jour. Amer. Concrete Inst.*, **1***A* [8], 108 (1930)). Too refined mathematical calculation cannot be applied to this subject without making the method valueless for practice. Advantages and disadvantages of the method, especially its speed of calculation, are illustrated. (*Jour. Amer. Concrete Inst.*)

Synthoporit, a new lightweight structural material. H. F. KRAUSE. *Zement*, **20** [16], 372–74 (1931).—A porous material is prepared from a fusion of calcium silicate. The melt leaves the furnace at 2730 to 2910°F and is chilled by a patented process. Cold slag is then broken and sieve separated into certain fractions. The material consists of about 20% solids and 80% voids. It floats on water even after 3 months. It is not affected by high temperatures and its strength is not materially decreased when used as concrete aggregate and exposed to high temperatures. Chemical composition is close to wollastonite, 47 to 49% SiO_2, 2 to 4% Al_2O_3, 0.2 to 0.5% FeO, and 43 to 45% CaO. Sulphur is below 0.3%. Specific gravity is 0.6. Voids are mostly closed and do not absorb much water. It is highly heat insulating. The greatest field of application is concrete. It is used for manufacture of slabs, lightweight brick, ceilings, encasings for steel structures, and walls. Concrete with synthoporit as aggregate has favorable strength properties. (*Jour. Amer. Concrete Inst.*)

Influence of firing temperature upon some technically important properties of ceramic bodies. J. MATĚJKA AND A. NIKITIN. *Stavivo*, p. 219 (1930); for abstract see *Ceram. Abs.*, **10** [3], 231 (1931). (*Trans. Ceram. Soc.* [Eng.])

Correction to the paper, "The volatility of silicic acid with water vapor." C. J. VAN NIEUWENBERG AND H. B. BLUMENDAHL. *Rec. trav. chim.*, **50**, 338 (1931).—Quartz particles covered with a layer of tridymite were mistaken for cristobalite. The reported transformation of the latter into tridymite at 395° is, therefore, incorrect and Fenners' diagram is not contradicted. Traces of metastable cristobalite, identified by dilatometric measurements, were noted at temperatures as low as 225°. See also *Ceram. Abs.*, **10** [2], 152 (1931). (*C.A.*)

Nitrate fields of Chile. J. A. BENN. *Discovery*, **12**, 155–57 (1931).—The Chilean nitrate industry is undergoing great changes owing to competition of synthetic nitrogen products. New processes are illustrated. H.H.S.

BOOKS

A Comprehensive Treatise on Inorganic and Theoretical Chemistry. Vol. XI. J. W. MELLOR. Longmans, Green & Co., 1931, 909 pp.—The arrival of a new volume of this important reference book brings us appreciably nearer the completion of the whole undertaking, which is unparalleled in the English language. The present volume deals with the following elements: tellurium, 121 pp.; chromium, 362 pp.; molybdenum, 189 pp.; tungsten, 202 pp. It is thus of considerable metallurgical interest. Illustrated. For Vol. X see *Ceram. Abs.*, **10** [5], 392 (1931).
(*Bull. Brit. Non-Ferrous Metals Research Assn.*)

Technical Methods of Chemical Analysis. III. G. LUNGE AND C. A. KEANE. Gurney and Jackson, London. Price £3-3-0. *Can. Chem. Met.*, **15** [5], 80 (1931).—This third volume of the series deals with ceramic products, glass, cements, water, sewage, fertilizers and feeding stuffs, soils, and air. See also *Ceram. Abs.*, **10** [9], 669 (1931). E.J.V.

Course in Physics. (Cours de physique.) A. LABAY. **Vol I. Acoustics and**

Electricity. 665 pp. **Vol. II. Thermodynamics and Optics.** 736 pp. Published by Gauthier-Villars, Paris. Reviewed in *Chaleur ind.*, **12**, 265 (1931). A.J.M.

Elutriation Analysis. (Die Schlämmanalyse.) HERMANN GESSNER. vii + 244 pp. Akademische Verlagsges., Leipzig, 1931. Price 18 Rm. Reviewed in *Analyst*, **56**, 352 (1931).—Grain size of muds, slimes, soils, and fine suspensions is dealt with. H.H.S.

PATENTS

Production of industrially valuable beryllium salts from beryllium-bearing minerals. HELLMUT FISCHER. U. S. 1,815,056, July 21, 1931. The method of obtaining industrially valuable beryllium salts which comprises heating a mixture of a beryllium-bearing mineral with a silico fluoride at a temperature above 600°C for so long a time that the mixture sinters without fusing, crushing the sintered product, leaching the same with cold water, and separating beryllium salts from the solution so obtained.

Treatment of zinciferous materials containing cadmium. HOWARD M. CYR AND ROBERT K. WARING. U. S. 1,817,068, Aug. 4, 1931. The improvement in the treatment of zinciferous material containing cadmium which comprises subjecting the material to a heat-treatment operation in the presence of a chloridizing agent and water vapor and under conditions of basicity favorable to effective utilization of acidic compounds of chlorine for chloridizing cadmium and thereby effecting the removal from the material by volatilization of such an amount of cadmium without substantial loss of zinc that the so-treated material is of sufficiently low cadmium content for the pyrometallurgical production of a high-grade zinc product therefrom.

Manufacture of lithopone. CLAYTON W. FARBER. U. S. 1,817,183, Aug. 4, 1931. In the manufacture of lithopone, the improvement in the precipitation of the crude lithopone which comprises mixing solutions of zinc sulphate and barium sulphide with a degree of agitation substantially equivalent to that obtained when employing a tank 15 ft. in diameter and 7 ft. deep having a conventional stirring device that is rotated at a speed of not more than about 5 r.p.m., whereby there is produced a crude lithopone precipitate containing uniformly aggregated particles composed of from 2 to 8 individual particles in an amount greater than the amount of primary particles and aggregates composed of more than 20 particles.

Manufacture of lithopone. JAMES ELIOT BOOGE. U. S. 1,818,190, Aug. 11, 1931. In the manufacture of lithopone, the step of imparting to the lithopone the property of producing a quick-drying paint when mixed with a vehicle such as bodied oil, etc., which comprises adding to the calcined lithopone a sufficient amount of a zinc solution to bring the total amount of basic-zinc compounds of the finished lithopone, calculated as zinc oxide, up to a predetermined figure, and thereafter precipitating the zinc as a basic-zinc compound by the addition of a basic substance in such quantity that the final product, when subjected to a precision alkalinity test with methyl orange as an indicator, requires from 1 to 15 cc. of $N/50$ HCl for titration to a faint pink color of 100 cc. of a clear filtrate obtained from a mixture of a 50-g. sample of the final product with 250 cc. of distilled water agitated for 5 min. at a temperature between 65 to 75°F.

Treatment of borax ores. H. BLUMENBERG, JR. Brit. 352,137, July 15, 1931.

Production of calcium borate and sodium nitrate. H. BLUMENBERG, JR. Brit. 352,138, July 15, 1931.

General

Moratorium in undergraduate school training. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **10** [8], 267–68 (1931).—It is suggested that there have been too many students allowed to undertake undergraduate ceramic courses and that a limitation of the number

would result in the release of money and technical men of the teaching staff for the investigation of ceramic problems. The need of proved and applicable information is greater than the need of inexperienced graduates. E.J.V.

Suggested factory performance index. W. KEITH MCAFEE. *Bull. Amer. Ceram. Soc.*, **10** [9], 282–87 (1931).

Refractory protective coatings. ANON. *Feuerungstechnik*, **19** [7], 112–13 (1931).—The best coating for protection against fire and water-laden steam is a filling material of milled sand or other siliceous stone. The fineness of the ground material must range from 0.03 to 0.2 mm. and if hard stone is used, 20 to 50% of a finely ground product such as fired loam or talcum can be added. The binding agent is water glass of 30° Bé (specific gravity 1.27), or better, a mixture of equal parts of soda and potassium water glass. With this combination the protective layer is resistant to steam and sufficiently stable and refractory after 5 days. The amount of water glass is 3% of the dry material, taking into consideration the amorphous silicic acid of the water glass. An addition of 5 to 10% oxides of Fe, Al, Pb, Ca, Mg, and Zn increases the stability. The paste is applied with a brush immediately before use. M.V.K.

Water-cooled fire boxes. F. MÜNZINGER. *A.E.G. Mitt.*, **1**, (under heading, "Das Kraftwerk," pp. 16–23) (1931); *Feuerfest*, **7** [6], 93 (1931).—The advantages obtained in cases where cooling surfaces were installed in dust and grate furnaces for raw brown coal and coke are demonstrated. M.V.K.

Air-receiver installation and care. WALTER B. LENHART. *Rock Prod.*, **34** [14], 46–47 (1931).—The causes of air-receiver explosions, which often result in loss of life and property, have been studied. L. suggests methods of eliminating them. Illustrated. W.W.M.

Fundamentals and economics in the clay industries. VII. ELLIS LOVEJOY. *Clay-Worker*, **96** [1], 24–28 (1931).—Prospecting clay beds should be done by an engineer who has some knowledge of the geology of the district and is also experienced in clay-working problems and troubles. Details of methods used in prospecting various types of clay deposits are given. As these methods are affected by the make-up of the deposits to a great degree, several of the various types of deposits are described in detail and the best method to be used on each is mentioned. Illustrated. For Part VI see *Ceram. Abs.*, **10** [9], 638 (1931). E.J.V.

Prospects of the china clay industry. E. H. DAVISON. *Times Eng. Supp.*, **28**, 242 (1931).—The association of clay-producing companies which controlled output and prices in England broke up in Nov., 1930. Owing to the drop in price, U.S. consumers are reverting to the use of English clay. H.H.S.

Economics of the nonmetallic mineral industries. VI. Marketing service as an important sales aid. RAYMOND B. LADOO. *Rock Prod.*, **34** [16], 30–31 (1931).—L. stresses the importance of marketing service to customers as an aid to sales, and explains what is meant by marketing service and how it is carried out. For Part V see *Ceram. Abs.*, **10** [9], 667 (1931). W.W.M.

Coöperation in the brick industry. W. GRESSLER. *Tonind.-Ztg.*, **55** [52], 752–53 (1931).—The necessity of coöperation in the heavy clay industry, especially in the brickmaking industry, and the benefits to be expected for each plant are pointed out. W.M.C.

Reducing costs in manufacturing. ANON. *Rev. mat. constr. trav. pub.*, No. 260, pp. 81–85*B* (1931).—To reduce costs in manufacturing, a thorough knowledge of the enterprise as a whole and in all its parts is necessary. This knowledge is best gained through statistics. Examples are given of daily, monthly, and annual statistics for a brick and tile plant. M.Y.H.

New failures of the flat roof. ANON. *Tonind.-Ztg.*, **55** [52], 755 (1931).—Several

examples of failure of flat roofs are given which led in some cases to the replacement by inclined ones. W.M.C.

Pulverized fuel firing in the U.S. VERNON WALKER. *Elec. Rev.*, **109** [2799], 95 (1931).—The report of the Prime Movers Committee has been issued for the year 1929 to 1930 by the National Electric Light Assn. of New York. During the year 1929, pulverized fuel was installed in approximately 70% of the coal-fired central station plants, either constructed or completed during that year. An accompanying diagram shows the total hourly evaporative capacity of all powdered-fuel fired boilers installed in public utility stations for each year since the adoption of powdered fuel, and the comparative capacities equipped for the direct (unit) or storage systems. E.P.R.

Clay Products Surety Co., Inc. JACOB PFEIFFER. *Brick Clay Rec.*, **79** [1], 31–32 (1931).—There is presented a tentative plan for establishing a surety company in the clay industry for the purpose of insuring clay products. The results such a plan would produce are enumerated. The proposed insurance would cover failure of clay pipe due to the following conditions: (1) oxidation in the form of rust or electrolysis, (2) decay caused by bacterial action, (3) disintegration caused by actions of acids or alkalis, and (4) disintegration caused by freezing water after being first absorbed into the porous walls of the pipe. E.J.V.

Some uses of silica. ANON. *du Pont Mag.; Rock Prod.*, **34** [16], 43 (1931).—"What Shall We Do with This Mountain of Glass?" is the title of a story giving a great many uses of silicate of soda. An accompanying chart shows all the related uses of this product made from sand in the field of cements, deflocculants, textiles, and adhesives. W.W.M.

Shordrucks. ANON. *Pottery Gaz.*, **56** [650], 1097–99 (1931).—A shordruck is that heap of broken, fired pottery, saggers, and various other useless material which occurs as the results of the continual cleaning up of pottery factories, workshops, ovens, and warehouses. Some are being utilized for making land and filling in low-lying land. Illustrated. E.J.V.

1930 Construction costs. ANON. *Engineering News-Record, New York. Pit & Quarry*, **22** [9], 71 (1931).—A national index of general construction costs in the U.S. for the year 1930 is presented. E.P.R.

Silicosis compensation schemes. ANON. *Statutory Rules & Orders*, No. 343, 9 pp. (1931); B.N.F.M.R.A., Serial 9137; *Refrac. Jour.*, **7** [7], 339 (1931).—The Various Industries (Silicosis) Scheme, 1931, made under the Workmen's Compensation Act, 1925, came into force on June 1, 1931, and is in substitution for the 1928 and 1930 schemes. The scheme applies to all workmen employed at any time on or after its commencement in the following processes: (1) mining and quarrying of silica rock; (2) drilling and blasting in silica rock incidental to the mining or quarrying of other minerals, including in potteries, the milling of flint or crushing or grinding of silica rock or dried quartzose sand; (3) any process in or incidental to the manufacture of china or earthenware including sanitary earthenware, electrical earthenware, and earthenware tile, up to, and including the preparation for glazing but excluding underglaze decorating, and modeling and moldmaking where these processes are carried on in separate rooms; and (4) polishing, sorting, or grinding on a power-driven wheel in connection with the grinding of glost ware and tile-slabbing. The scheme does not apply to the employment of a workman in any process included in the Refractories Industries (Silicosis) Scheme, 1931, the Metal Grinding Industries (Silicosis) Scheme, 1931, or the Sandstone Industry (Silicosis) Scheme, 1931. E.P.R.

Dust found harmful in plants and quarries. ANON. *Pit & Quarry*, **22** [9], 14 (1931).—Dust around quarries and stone-cutting plants, containing large percentages of free silica, was most harmful to the health of the workers in the plants. The U.S.

Health Service also found a high-dust content in the air in cement plants, though this dust was not as harmful as the free silica dust. E.P.R.

Behavior of lead in animal organisms. R. A. KEHOE AND F. THAMANN. *Amer. Jour. Hyg.*, **13,** 478–98 (1931); *Analyst*, **56,** 331 (1931).—Poisoning by lead tetraethyl is not different from lead poisoning by other lead compounds. H.H.S.

Etymology of the word "ceramics." P. WETZEL. *Sprechsaal*, **64** [30], 559–60 (1931). W.M.C.

General Ceramics introduces four new products. ANON. *Ceram. Ind.*, **17** [2], 154–56 (1931).—The General Ceramics Co. exhibit at the National Exposition of Chemical Industries in New York introduced four new ceramic products for use in the chemical and allied industries. They are Cerawite, Ceramit, Pyrotone, and Baridal. All are described in the article. W.W.M.

Merger of refractories plants. ANON. *Nat. Glass Budget*, **47** [15], 3 (1931).—Three firms were merged into a $5,000,000 corporation when the Laclede-Christy Clay Products Co. is said to have purchased the assets of the Buckeye Clay Pot Co., as well as those of the Walsh Clay Products Co., which is understood to be the refractory division of the Mississippi Glass Co. E.P.R.

Thirty-Third Annual Meeting of the American Ceramic Society. ANON. *Ceram. Age*, **17** [4], 189–218 (1931); *Chem. Met. Eng.*, **38** [3], 144 (1931).—A description is given of the Annual Meeting. R.G.M.

French Association for Testing Materials. ANON. *Rev. mat. constr. trav. pub.*, No. 260, pp. 198–200 (1931).—Papers presented at the meeting were (1) "Apparatus for the measure of the permeability of materials of construction," by GUILLERY, and (2) "Some modern methods of determination applied to the analysis of cements," by RENGADE. M.Y.H.

Ceramic Society in Germany. III. ANON. *Pottery Gaz.*, **56** [650], 1114–17 (1931).—The tour was brought to a conclusion in Berlin. Here the State Porcelain Factory was visited and several ceramic plants and research institutes and laboratories in the vicinity of Berlin were inspected. Illustrated. For Part II see *Ceram. Abs.*, **10** [9], 650 (1931). E.J.V.

Jubilee meeting of the German Association of Refractory Manufacturers. ANON. *Tonind.-Ztg.*, **55** [52], 749–52 (1931).—The meeting of German Associations of Refractory Manufacturers, celebrating the 50th anniversary of this Association held in June, 1931, is reported. W.M.C.

Meeting of the German Association of Sand-Lime-Brick Plants. ANON. *Tonind.-Ztg.*, **55** [58], 845–46 (1931).—The June meeting is reported. W.M.C.

Association sets tentative dates for 1932 glass and pottery exhibit. ANON. *Nat. Glass Budget*, **46** [38], 3 (1931); *Amer. Glass Rev.*, **50** [18], 14 (1931).—Continuation of the Pittsburgh Glass & Pottery Exhibit was indicated by action taken at the Annual Meeting of members of the Associated Glass & Pottery Manufacturers held at the Fort Pitt hotel on January 22 prior to the close of the 1931 show. The members reëlected the board of directors and recommended that the 1932 exhibit be held in Pittsburgh and start on January 11. E.P.R.

Paris International Colonial Exhibition. ANON. *Times Eng. Supp.*, **28** [668], 32 pp. (1931).—Held May to Nov., 1931. The industries of the French Colonial Empire are fully represented, and there are American and other foreign pavilions. The mosaics of Morocco are especially pointed out. H.H.S.

Czechoslovakian ceramic museum in Prague. ANON. *Keramos*, **10** [13–14], 360 (1931).—The plan of the museum is outlined. M.V.K.

Exhibition of fine ceramic ware at the building exposition in Berlin. OTTO

PFLEIDERER. *Keramos*, **10** [13–14], 357–60 (1931); see also *Ceram. Abs.*, **10** [9], 667 (1931). M.V.K.

BOOKS

Industrial Organization. HARRY RUBEY. Ginn & Co., Boston, Mass. 308 pp. $2.80. Reviewed in *Elec. World*, **96** [3], 122 (1931).—This is a valuable and readable book for the engineer seeking to quickly acquire an understanding of the basic features of modern business organization. In concise but clear form are set forth the major outlines of promotion, finance, management, organization, advertising, marketing, purchasing, insurance, personnel, research, accounting, statistics, and valuation as these enter industry today. Excellent bibliographical references are included by chapters. G.R.S.

Methods of Research in Industrial Chemistry. (Chemisch-technische Untersuchungsmethoden.) BERL, ET AL. 1260 pp., 583 figures, 2 plates. Published by Julius Springer, Berlin. Reviewed in *Chaleur ind.*, **12**, 266 (1931). A.J.M.

Industrial research laboratories of the U.S. C. J. WEST AND C. HULL. *Bull. Nat. Research Council*, No. 81, 267 pp. (1931); Serial 9019.—The authors give information regarding 1620 industrial research laboratories (including consultant's laboratories) in the U.S. (*Bull. Brit. Non-Ferrous Metals Research Assn.*)

Publications of the Kaiser Wilhelm Institute for Silicate Investigation in Berlin-Dahlem. WILHELM EITEL. *Naturwissenschaften*, **19** [5], 115 (1931); for abstract see *Ceram. Abs.*, **10** [6], 462 (1931). L.T.B.

PATENTS

Chemically solidifying earth. MICHAEL MÜLLER. U. S. 1,815,876, July 21, 1931. The process of chemically solidifying earth which consists in saturating the earth with silicic acid containing substances and then applying chlorine to it.

Production of materials adapted to be molded and fired from raw material containing lime. B. JIROTKA. Brit. 352,665, July 22, 1931.

Apparatus for the manufacture of clay bodies. J. W. CRUIKSHANK. Brit. 353,410, Aug. 6, 1931.

Book Reviews

Annual Survey of American Chemistry. Vol. V. Edited by CLARENCE J. WEST. Published for the National Research Council by the Chemical Catalog Co., Inc., New York, 1930. 629 pp. Price, $5.00. Forty chapters of a condensed review of the most important studies during the year 1930 in America written by foremost investigators make this book a valuable reference. In the chapter entitled "Chemistry of the Silicates," G. W. Morey gives 70 references to books and researches. The only criticism of omission is that Morey has not definitely defined the silicate chemistry of clays and glass as being collectively ceramics. Ceramics, being the art of producing by fire useful things from silicates, includes all silicate studies. Geochemistry and ceramics share benefits from all silicate investigations.

Annual Reports of the Society of Chemical Industry on the Progress of Applied Chemistry. Vol. XV. 758 pp. Published by Society of Chemical Industry, London, 1930. About fifty pages of this book are devoted to subjects of interest to ceramists. In the section entitled "General, Plant, and Machinery," the recent work on the following topics is reviewed: crushing and grinding, filtration, sedimentation, drying, and instruments and plant equipment. Under "Fuels," reports are given on pulverized fuel, furnaces, and industrial heating. The summary on aluminium salts includes the review

of the many existing processes for production of alumina from clays, ores, etc. A modification of Hall's process is described. The voluminous output of published research work on glass, with the rounding off of certain work, *i.e.*, the effect of cullet on the properties of glass, is noted. The manufacture of glass, glassmaking materials, the constitution of glass, chemistry and physics of silicates, and physical and optical properties of glass receive considerable attention. The causes and measurement of the plasticity of clay have been the subject of several researches. Other topics under clay are (1) drying cracks, (2) the effect of varying grain size of the grog in sagger mixes, (3) additions of over 60% of fused alumina or precalcined diaspore to plastic bond clay and its influence on refractoriness and refractoriness under load, (4) effect of reducing atmospheres on the load-bearing capacity of fire brick, (5) influence of oxidizing and reducing atmospheres on the properties of a refractory material containing added colloidal $Fe(OH)_3$ and carbon, (6) constitution of clay using the X-ray diffraction pattern, and (7) corrosion of fireclay blocks and tank blocks. Refractory materials are reported under alumina, sillimanite, chrome and silica brick, mixtures of refractory oxides and silicates, and the testing of refractory materials. Porcelains and kilns conclude this section. Much space is devoted to research on soils. The crystalline nature of colloidal clay includes reviews of X-ray and petrographic analyses of clay colloids. Sensitive tests for the presence of base-exchange material in soils and rocks are given. Mechanical analysis and physical properties of soils include descriptions of modifications of methods and development of new processes. The formation of the "Rheology Society" is noted. The adoption of the name "rheology" for the study of the flow of matter should be followed by the adoption of specific terms for the various constants derived from the flow curves and thus relieve the overworked word "plasticity" of a few of its alternative meanings. Each review is accompanied by the names of the research workers. References are given to the literature on all of the reports making the book extremely valuable in bringing together the work done during the past year for the various topics cited. G.R.SHELTON

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Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

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EDITORIAL

QUALITY CONTROL SYSTEM IN A PORCELAIN INSULATOR PLANT[1]

BY E. H. FRITZ

The need of developing and improving the control of quality in the manufacture of ceramic products became apparent when these products and their manufacture were studied from a scientific standpoint. In every process of manufacture in which the ceramic engineer interested himself, conditions were found, the causes of which could not be definitely determined because too little was known about the behavior of the various materials in the manufacturing processes. Control of them under such circumstances would necessarily be empirical or would depend upon the skill of the workman. This placed it on an art basis rather than on the desired scientific basis. The situation today, however, is different because of the increased attention that has been given to developing an adequate quality control for all ceramic products, and it is only by actively continuing

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this work that the ultimate goal, control on a completely scientific basis, can be reached.

In the manufacture of porcelain insulators this problem for some time has been given the attention it deserves and a great deal has been accomplished. The control which has been developed in the plant in which the writer is interested, has, in its accomplishment, had the benefit of the control system which is used by the parent company. In the writing of raw material and process specifications considerable assistance was obtained from this source. These specifications are the basis of the control and are necessary to any quality control. They should contain all of the information and data possible to record that is vital to the control of the raw materials and the manufacturing process. The preparation and keeping up-to-date of these specifications are the responsibilities of the ceramic engineer.

It naturally follows, since the ceramic engineer is responsible for the preparation of all specifications, that he also has the responsibility for their observance. With us, a plant laboratory is available with the necessary equipment for the various tests. The ceramic engineer and his assistants are a part of the engineering department of the works, and as such are entirely independent of the manufacturing department and do not report to anyone in the manufacturing organization. This form of organization, *i.e.*, keeping the ceramic engineer out of the control of the manufacturing department, is essential to obtain proper consideration of his findings, recommendations, and requests. If he is attached to the manufacturing department, these items too often become secondary to production problems or are considered too costly and consequently are never carried out. In a separate engineering department they cannot be ignored, for a manufacturing department cannot proceed in any business without the support of the engineering department.

In those ceramic industries where no engineering department is maintained besides the ceramic engineer, he should report to the general manager or chief executive of the entire organization. Coöperation between the two departments must of course exist and in this respect the ceramic engineer must at all times fit his demands to suit manufacturing conditions as much as possible. Under no conditions, however, does he sacrifice quality of an essential nature for this reason, and it is under these conditions only that the separate department is effective since he will have great difficulty in obtaining observance of a demand which apparently decreases production if he is a part of the manufacturing department. Many of these demands, which are considered more costly by the manufacturing department, are actually not costly if they are tried long enough to manipulate them in the best way. In other words, a trial of considerable length should always be made before judgment is passed. Items, which after sufficient trial do

increase cost, must be justified by a contribution to quality or its control. If this cannot be done, they should not be insisted upon by the ceramic engineer. If he handles his work on a fair common-sense basis, he will command the respect of the manufacturing department and have little difficulty in securing its coöperation when he requests it.

The raw-material specifications are the beginning of the control system and should be prepared for every material that enters into the final product, or helps to make it. For some materials, such as glaze materials, specifications may seem unnecessary because the possibility of variations seems remote. This can never be taken for granted however, and in the type of materials cited, if a glaze becomes variable it may be due to a change in one of the component materials which a check against a specification would have disclosed.

Specifications for clays may seem inadequate and are inadequate as long as it is not possible to determine such things as plasticity and casting qualities quantitatively. These remain as problems to be solved in developing a more scientific quality control. Nevertheless, it is possible to write in the clay specification those properties which can be evaluated and which may be important to quality. With a specification in force, a closer check results, not only by the consumer, but also by the producer, and which may be instrumental in finding more data about the clays or materials involved and may ultimately lead to a more adequate specification. Our clay specifications cover moisture content, residue on 150-mesh lawn, modulus of rupture in dry state, absorption at cone 10, and dry and fired linear shrinkage. Difficulty will sometimes be encountered in obtaining the producer's approval of a specification. If the specification is fair, however, and is based on a past performance which is satisfactory, it should be possible, if presented properly, to obtain the support of the producer.

If the raw-material specifications are to be of any value, it is important that all shipments be tested against the specification immediately upon arrival so that rejection, if necessary, can be made before the lot is needed for production. Most plants are not equipped to make these tests before unloading but they should arrange for segregation of the material after unloading until all tests are completed. Even when this is not possible and the shipment must be immediately mixed with the supply on hand, if the tests reveal an unsatisfactory or suspicious condition, steps can be taken to clear this up before any further shipments are made.

The process specifications should cover every step in the manufacturing process from taking the raw materials from the bins to packing the final product for shipment. On account of the large amount of data necessary, it is advisable to have separate specifications for the work in each manufacturing department, such as preparation of body, preparation of glazes, fabrication of product, etc. In the specification for preparation of the body,

the body composition and the steps to be taken to make allowances for the moisture in the clays are specified first. These are followed by the grinding of the flint and feldspar, the amount of materials and water composing the charge to be ground, the extent of the grind, and the allowable residue on 325-mesh lawn after grinding. Further check on the proportion of materials and water is obtained by specifying the specific gravity of the ground charge. The level of the stones in the ball mill is also covered. The charge for the blungers is given, including the amount of water to be added at the start, subject to later additions depending upon the viscosity and specific gravity of the slip, and the blunging time before and after the flint and feldspar are added. Viscosity and specific gravity values of the slip are given and in case they cannot be maintained, notification of the ceramic engineer is directed. The mesh of the lawns together with their operation, the magnets with a statement as to frequency of cleaning them, the storage of the slip in the cisterns, and the minimum time under agitation before filter pressing are followed by the method of filter pressing including limits on time and pressure. The care of the filter presses and sacks is also included. The handling of the filter cakes through the initial pugging operation is given in detail together with a check on the consistency by means of a gage and the storage of the pugged material in the cellar. The final pugging follows where checks for consistency and laminations are given. Nothing can leave the pugging department which does not meet the requirements and if there is difficulty in meeting them, the ceramic engineer must be notified. The pug mill set-ups are completely specified, including the pitch, type, and number of knives for each mill, and the restriction between mill and nozzle that is to be used with the various sizes of nozzles. These are briefly the points covered in this particular specification.

In a similar manner the preparation of the casting body is given. In this case, viscosity and specific gravity are of extreme importance and no deviation from the limits given is allowed for any charge without written authority from the ceramic engineer. The same general plan is followed in the process of fabrication of the insulators whether by the plastic or cast process. Such items as the pouring or placing of the slip or plastic body in the molds, the temperature and humidity of the driers, and the drying time are definitely specified. In connection with the making of various designs there are always some things that must be done that are peculiar to the design; for instance, the size of pug to be used or the exact details of filling the mold with slip. Obviously, this information, while important, would make the process specification too lengthy. It is therefore kept as manufacturing information by style number, each manufacturing department keeping its own data in which it is directly interested.

In regard to the glazes and their application, a separate specification covers

the composition, preparation, and final checks on a viscosity and specific gravity basis of all glazes before they are released to the manufacturing departments requiring them. The care of the glazes, method of using them, and subsequent checks after they are in the manufacturing department are given.

The firing of the kilns, both tunnel and periodic, is carried in separate specifications for each type of kiln. While the success of this opeartion must necessarily depend to a considerable extent upon the judgment of the kiln fireman, many important items such as temperature cycle, progress of cone deformation, draft and pressure readings, adjustment of fans and dampers, and gas pressure, each for the various car schedules can be definitely specified. It is an easy matter in the firing of kilns, and in many other operations, to make changes on the spur of the moment in the hope of improving a condition. These lead to further changes and in the end one does not know how near or far he is from his original condition if no process specification is available. With it, this can never happen.

From this general description of the process specifications, it is obvious that the ceramic engineer and his assistants have many things to do in checking the processes against the specifications and in taking care of situations where there is difficulty in meeting the specification or where the specification does not work out satisfactorily. Many routine checks, particularly those for viscosity and specific gravity of the various slips, are made by the manufacturing department. The data for each charge in such cases, however, is carefully recorded in a book for permanent record and in this way the ceramic engineer at all times knows what is going on. Similarly the kiln fireman records all of the measurements and data covered in the specification. The system of having each manufacturing department make its own checks as far as possible is encouraged because it gives the department a greater interest in the work and increases its feeling of responsibility. It has a psychological effect of more diligent striving to maintain the standards called for, thus assisting control of quality. It also avoids delay in having these checks made and recorded and thereby prevents the control system from becoming burdensome.

While the raw-material and process specifications form the basis and major part of the quality control system, the description is not complete without some mention of the test specifications and the routine tests on the finished product. The test specifications cover the inspection and test of the entire product before and after assembly. These tests are of an electrical and mechanical nature. Inspection is extremely important and unless high standards are maintained and conscientiously followed, a system of quality control is of little value. Here again it is important that the inspection department not be responsible to the production department in order to prevent lowering of standards because of some urgent production

requirement. Furthermore, because of the tedious nature of inspection work it must be made worth while so that it will attract intelligent and faithful inspectors. The records of inspection and test on the entire product, showing the amount of rejections, are kept. These which not only provide a continuous measure of the success of the operations but are also of value at subsequent periods when it is desired to compare performance with a previous time when a somewhat different process was being followed. In addition, the test specifications also specify that a certain percentage of each lot of the more important design types, such as suspension insulators, be tested to destruction. A record of these tests is kept which gives a continuous history of the performance of the product. The routine tests which supplement those called for by the test specifications include such tests as porosity by dye penetration under pressure which is made daily, modulus of rupture on $^3/_4$-inch rods from daily production with and without quenching, ice-box tests on designs selected in a definite way daily from the kilns, and a monthly chemical analysis of the porcelain. Where possible, the record of these various performance tests of the finished product is kept graphically, which is an interesting exhibit of the progress made over periods of time and the degree of uniformity obtained from day to day.

The work of the ceramic engineer in cases where there is difficulty in meeting the process specifications involves experimental and development activity in order to arrive at the best process. Furthermore, he must constantly have in mind the improvement of existing processes in order to improve the product or lower its cost. In many cases this means research and in plants where no separate research department exists; the activities of the ceramic engineer should therefore embrace both research and materials and process engineering. Under these conditions, however, the two types of work should be kept distinctly separate and, as far as possible, should be carried on by separate personnel. Otherwise, the progress of the research work will not be satisfactory because the materials and process activity is intimately associated with production. This occasions many interruptions and various activities in a single day, all of which is not conducive to good research work. When the ceramic engineer is responsible for work of such importance and of such wide scope, it is imperative that he be entirely independent of the manufacturing department and not subordinate to it.

A quality control system can be only as effective as the degree of interest in quality of the organization charged with carrying it out. Every plant should have some system of quality control but the time required to develop it will be needlessly spent if the interest in quality is half-hearted or evident only when it does not interfere with other activities and problems.

WESTINGHOUSE ELECTRIC & MFG. CO.
DERRY, PA.

ACTIVITIES OF THE SOCIETY

GLASS DIVISION SUMMER MEETING SEPT. 11–13, 1931

Trips and Recreation

More than fifty members of the Glass Division and their guests attended the Annual Summer Meeting which included the trip via Old Bay Line steamers to Old Point Comfort, Virginia, two days at the Hotel Chamberlin, and the return trip up the Bay on Sunday night.

On Saturday morning various groups enjoyed the salt water pool at the Hotel, fishing and swimming from small boats out in the Bay, and visiting Fortress Monroe with its historic surroundings and officers' quarters of old Southern architecture.

Other groups were contented to form friendly circles on the wide verandas of the Hotel and watch the bathers and fishermen and the incoming small boats carrying officers and men from the fleet of the U. S. Navy anchored in the Bay.

In the afternoon the same sports were enjoyed and two groups visited historic Yorktown, Williamsburg, Jamestown, and other points.

E. L. Hettinger, W. A. Oakley, and H. E. White presented to the AMERICAN CERAMIC SOCIETY a brick taken from the old church at Jamestown. This building is reputed to be the first brick church in the United States. The brick will be on exhibit in the office of the AMERICAN CERAMIC SOCIETY and will be duly authenticated and labeled.

Glass Division Dinner and Technical Session

Every member of the party attended the dinner which was held at the Hotel Saturday evening.

A business meeting and technical session followed presided over by G. W. Morey, Chairman of the Glass Division. A report of the Education Committee was given by Mr. Hettinger, whose recommendations will be published later.

W. A. Taylor of the Corning Glass Works presented a report from the International Glass Standards Committee on standards for thermal expansion and viscosity of glass.[1]

In the discussion following this report two resolutions were passed.

(1) It was moved by Mr. Purdy that the Standards Committee of the Glass Division coöperate with foreign research groups in the standardization of the definitions and methods of tests.

(2) Mr. Blunt made a motion that the Committee consisting of J. T. Littleton, W. A. Taylor, and F. W. Preston present a report on glass standards at the February meeting in Washington.

The meeting was then adjourned for the entertainment which followed.

Entertainment Following Meeting

F. W. Preston and J. W. Krisko presented a program of mind reading, sleight of hand, and actual conjuring with wholly professional skill. Dr. Preston proved his ability in reading minds to such a degree that the members had to censor their thoughts as carefully as if the Navy search lights were revealing their minds to the world. Only when Mrs. Morey wrote out a question which seemed to Dr. Preston of entirely too dubious a nature to reveal to the guests, did he hesitate. Mrs. Morey later confessed that she had asked if Sunday would be as hot as Saturday had been, and Dr. Preston's

[1] For this report see this *Bulletin*, p. 321.

hestitation in refusing to answer this question was simply a desire on his part not to be mobbed for predicting another hot day. He also hesitated in answering Mrs. Turner's question predicting a second five o'clock call for rising. Mr. Krisko's clever hands mystified and pleased the guests. A rising vote of thanks was given by the members to Dr. Preston and Mr. Krisko and the party afterward became guests at the Admiral's dance which was held in the ball room.

Admiral Willard's Invitation to the Flagship Augusta

On Sunday morning the technical session scheduled for 9 o'clock was postponed because an invitation had been received from the Admiral to visit the flagship Augusta. This cruiser was completed in January, 1931. It is one of thirteen new cruisers to be built by the U. S. Navy, of which seven are now completed and in service. The Admiral's launch accompanied by an officer was sent ashore for the Glass Division party and they were received on the ship by the Lieutenant Commander and Admiral with fitting ceremony. The party was divided and was conducted through the boat by two officers who explained the use and construction of the many apparata necessary in the running of the ship. This examination took the party from the radio room down through the boiler room and back. Such an opportunity as this was greatly appreciated, especially by those who had never been aboard a cruiser before. Dr. Bailey proved useful as an additional guide inasmuch as his father was retired from the Naval service with the rank of Rear Admiral in the Engineering Corps.

Sunday Evening Technical Session

The second technical session of the Division was held on the roof garden of the Hotel and was presided over by Dr. Morey.

Two resolutions were passed at this meeting which were as follows.

(1) That the secretary of the Glass Division of the AMERICAN CERAMIC SOCIETY write a letter to Admiral Willard of the U. S. Navy, expressing the appreciation of the Division for his hospitality and the consideration he extended us in the visiting of his flagship, the Augusta, on Sunday, September 13.

(2) That the secretary of the Glass Division write a letter of approbation to Mr. L. C. Roche, who as chairman of the Committee arranged for the 1931 summer meeting of the Division.

The main feature of the meeting was the presentation of the paper, "Methods of Selecting the Most Economical Batches for the More Common Glasses with Respect to Material Cost of Melting and Refining," by L. T. Sherwood.[1] A short discussion followed after which the meeting was adjourned.

An hour later the Division members went aboard the steamer for dinner and the return trip to Baltimore. The entire week-end was an unqualified success due to the efforts of Mr. Roche of Baltimore and Mr. Finn of Washington, assisted by Harry C. Baker who conducted the tour. The members of the party are deeply indebted to these men for the excellent program of entertainment and the comfort and ease of the arrangements.

Glass Division Members and Guests Attending Summer Meeting

Babcock, M. G., Pittsburgh Plate Glass Co.
Bailey, James, Bailey and Sharp, Co., Inc.
Begeman, M. L. and wife, Mississippi Glass Co.
Blau, H. H. and wife, Macbeth-Evans Glass Co.
Blunt, R. A., Buck Glass Co.
Brenner, R. F., Roessler & Hasslacher Co.
Curts, R. M., Three Elephant Borax Co.
Finn, A. N., Bureau of Standards
Flint, F. C., Hazel-Atlas Glass Co.
Ford, Karl, wife, and son, Glass Containers Assn.

[1] For this paper see this *Bulletin*, p. 322.

Hettinger, E. L., Willson Products Co.
Heuisler, P. I., Jr., Maryland Glass Co.
Hilgenberg, Miss A. } Carr-Lowrey Glass
Hilgenberg, C. R. } Co.
Hommel, E., O. Hommel Co.
Hostetter, J. C., wife, and son, Corning Glass Works
Insley, H., Bureau of Standards
Kelsey, V. V., Consolidated Feldspar Co.
Kimes, A. W., *National Glass Budget*
Klinefelter, T. A., Bureau of Standards (Columbus)
Krisko, J. W., and wife, Butler, Pa.
Lester, W. R., Maryland Glass Co.
Littleton, J. T., Corning Glass Works
McComas, C. B., Carr-Lowrey Glass Co.
Miller, R. A., Pittsburgh Plate Glass Co.
Morey, G. W., and wife, Geophysical Laboratory
Navias, Louis, General Electric Co.
Oakley, W. W., and wife, Corning Glass Co.
Preston, F. W., *Glass Industry*
Purdy, R. C., AMERICAN CERAMIC SOCIETY
Roche, L. C., and wife, Maryland Glass Co.
Scholes, S. R., Columbus
Schulle, Miss E. M., Maryland Glass Co.
Sharp, D. E., Bailey and Sharp, Co., Inc.
Shelton, G. R., Bureau of Standards (Columbus)
Sherwood, L. T., Penn. Wire Glass Co.
Smith, M. A., and wife, McKee Glass Co., Jeannette, Pa.
Smith, G. O., Carr-Lowrey Glass Co.
Taylor, W. C., and wife, Corning Glass Works
Thompson, F. S., Corhart Refractories Co.
Tillotson, E. W., Mellon Institute
Turner, Mrs. L. P., Glass Division Secy.
Van Schoick, Miss E. C., AMERICAN CERAMIC SOCIETY
White, H. E., and wife, Lava Crucible Co.

I. The Thermal Expansion of Glass[1]

(A) Standard Method of Comparing Thermal Expansion

It was agreed that for general purposes of comparison the thermal expansion of glass shall be determined for a mean temperature of 50°. The actual range of temperature over which the determination is to be made shall be 25° ± 5° and 75° ± 5°. The temperature at each end of the range shall be maintained constant when carrying out the determinations for a period sufficient to ensure steady conditions.

The specimens employed shall be of a thickness of 5 to 6 mm. and shall normally be free from strain, the examination for strain to be done optically.

The symbol denoting the mean linear coefficient of thermal expansion shall be $\alpha 50°$ and this shall be understood as applying to a well-annealed specimen. If the glass specimen has not been annealed the symbol shall be $\alpha(50°)$.

(B) Measurements at High Temperatures

In the case of measurements made over a range of temperature from the normal room temperature upward it was agreed that the specimens shall be of a thickness between 5 and 6 mm. and that they shall normally be annealed, as in the standard method (A). A test piece shall be used once only, that is to say, the specimen shall have been cooled only once previously in the annealing process.

It was agreed that in determinations over a wide range of temperature the rate of heating shall be 2° per minute.

II. Viscosity

In regard to the viscosity, it was agreed that there are three temperatures of importance for the characterization of glass, namely:

(1) That corresponding with a viscosity of 10^3 c.g.s. units, to be regarded as the furnace working temperature.

This value is to be regarded as an average or corresponding with the working temperature.

(2) That at which the viscosity is 10^6 c.g.s. units, to be regarded as the temperature of the lower limit of the working range.

(3) That at which a break occurs in the temperature-property curve.

[1] Taken from Vol. 14, *Jour. Soc. Glass Tech.* [Proceedings], International Glass Standards, pp. 158–59, December, 1930.

The value of the viscosity at this point, when the property in question is the electrical conductivity, has been given as 10^{13} c.g.s. units. It is agreed that an accepted value shall be decided only after a comparison of additional measurements to be made on a series of properties, the rate of heating when carrying out these measurements to be 4° per minute.

III. Transformation Point Nomenclature

It is agreed that the symbol T_g shall replace all other conventions to denote the transformation temperature of a glass.

The maximum point reached on the complete thermal expansion curve for the glass, namely, the point normally corresponding with its softening temperature, shall be denoted by the symbol *Mg*, and that this symbol shall replace any other convention hitherto in use.

Methods of Selecting the Most Economical Batches for the More Common Glasses with Respect to Material Cost and Cost of Melting and Refining

By L. T. Sherwood

The proposed discussion concerns primarily the methods of choosing a batch and not the characteristics of any particular batch materials. A number of factors may enter into the choice of a batch, but the factor to be considered in this instance is economy. If, instead of being a matter of economy, the task were to make a glass of a specified density, of a specified thermal expansion, and complying with various other common specifications; the problem could be worked out rather precisely in the laboratory before undertaking commercial production. From published data, and without any experimental work, a batch satisfying ordinary requirements among properties such as mentioned could be approximated. Then, if desired, small melts could be made in the laboratory, density, thermal expansion, liquidus temperature, etc., could be actually determined and the batch could be modified until the requirements were fully met. There would be no guesswork about this procedure, nor would it be necessary to rely on tradition or hearsay. It seems reasonably safe to say that, having once in this way determined the batch needed to produce a glass complying with a given set of specifications, it could then be adopted commercially and the expected results could be obtained.

On the other hand, if a certain batch were used in a tank and an improved batch were worked out in the sense that it would produce an equally satisfactory glass, as delivered by a tank to machines, but would result in a net saving, considering both cost of materials and of melting, the problem, to say the least, would be less simple. It is well known that the bill for batch materials would be less if, for instance, the proportion of soda were reduced slightly and the sand correspondingly increased. It is known also that the melting cost would thereby be increased, but could it be certain in advance whether or not the net result of the change would be a saving or a loss? To be sure, compositions are often more or less unalterably fixed by requirements of machines or by specifications on the finished product, and in such instances economy of this sort could not be considered, but probably there are many factories in which such a study might pay well. Incidentally, a rather minor economy in batch, if applied to several continuous tanks, would pay the salary of a glass technologist.

It would not be amiss to digress and inquire how the more commonly used batches came about. In most factories, even at this time, batches are evolved mainly by practical men who have never been disciplined under the phase rule nor in their youth played hide and seek with entropy. Their conclusions in many instances perhaps cannot be

improved upon by scientists, but where these men have themselves actually solved new batch problems to the best advantage, they have experimented, not in the laboratory, but on a commercial scale; and, whatever may be said in its favor, that method is apt to be very expensive. Whenever commercial results can be reliably forecast in the laboratory, instead of staking thousands of dollars in the factory, it obviously pays to do so. This is true especially of those firms which operate only one or two tanks and can ill afford to tamper in the factory with a batch inherited from their fathers, which, whether the most economical or not, at any rate produces the required ware.

Whereas small quantities of glass from new batches can be made in the laboratory, and their densities, thermal expansions, etc., can be accurately measured, thereby predicting certain results in advance of commercial production, no laboratory procedure for accurately forecasting the relative melting and refining cost of an untried batch as compared with one for which such cost is already a matter of factory record is known. If the relative cost of melting and refining, could be predicted taking also into consideration such stray interlopers as scum, an estimate of relative economy, including cost of materials, it would, of course, be merely a bit of arithmetic. Those who have tried a method of predicting the cost of melting and refining, and have verified it in commercial practice, a description thereof would indeed be welcomed.

Perhaps it is not feasible to devise a method which would go so far as actually to determine an accurate ratio of costs in dollars, but may still be feasible to obtain sufficient information to serve as a useful guide. For instance, it would be useful, if it could be established as a fact that certain laboratory determinations would reliably answer Question No. 2 on viscosity in the memorandum preceding this paper. Perhaps determinations of viscosity, as have been suggested, would answer this question. Perhaps it could be answered by a series of laboratory meltings under precisely controlled conditions, during which certain observations would be made, as recorded in some of the papers of W. E. S. Turner and his co-workers. Or perhaps there are other more promising methods which have not come to our attention at all. It is hoped that the various possible methods and their probable merits will come to light in this discussion.

With this amplification of the earlier memorandum the lines of thought which are proposed for discussion will be clear.

The selection of the most economical batch for any given purpose is certainly of interest to all our employers, and their interest in research would be stimulated by further aid on our part. If the questions raised are difficult, should not their very difficulty challenge us to exert our best efforts?

PENNSYLVANIA WIRE GLASS CO.
DUNBAR, PA.

AMERICAN REFRACTORIES INSTITUTE FALL MEETING

The Fall Meeting of the American Refractories Institute will be held on October 8 and 9 in the Hotel Cleveland, Cleveland, Ohio.

Only committee meetings will be held on October 8, the technical papers and discussions being scheduled for October 9. The program is as follows:

Morning Session, 9:30 A.M.

(1) "Dry-Press Operations," by D. B. Hendryx, Chief Engineer, Harbison-Walker Refractories Co.

(2) "Improving Dry-Press Brick by the Removal of Air," by George A. Bole, Research Professor, Engineering Experiment Station, Ohio State Univ., Columbus, Ohio.

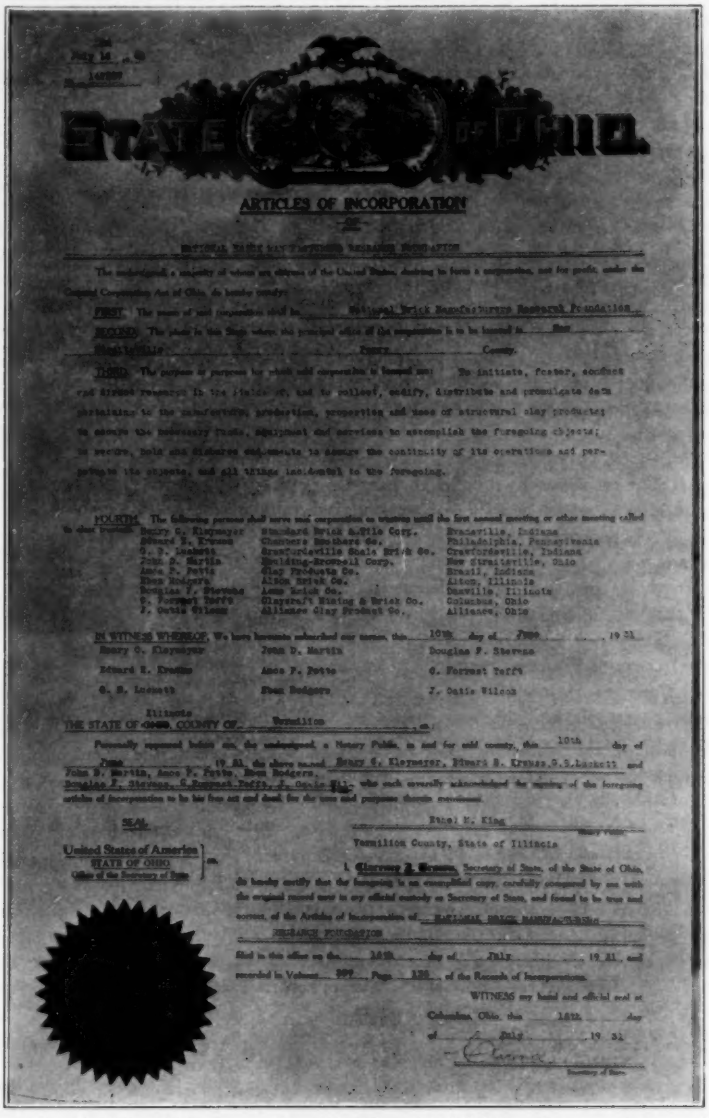
(3) "The Effect of Various Factors on Pressure Transmissions in Dry Pressing," by C. M. Dodd, Secretary, Committee on Dry-Press Process, Rolla School of Mines, Rolla, Mo.

Afternoon Session, 1:30 P.M.

(4) "Notes on Firing of Refractories," by S. M. Kier, Vice-President, General Refractories Co.

(5) "Permeability of Refractories to Gas at High Temperatures," by Stuart M. Phelps, Director, Refractories Fellowship, Mellon Institute of Industrial Research.

(6) Open session and discussion on Firing of Refractories, Causes of Kiln Marking, and Secondary Expansion.



ARTICLES OF INCORPORATION

FIRST. The name of said corporation shall be National Brick Manufacturers Research Foundation.

SECOND. The place in this State where the principal office of the corporation is to be located is at Fort Wayne, Fayette County.

THIRD. The purpose or purposes for which said corporation is formed are: To initiate, foster, conduct and direct research in the fields of, and to collect, codify, distribute and promulgate data pertaining to the manufacture, production, properties and uses of structural clay products; to secure the necessary funds, equipment and services to accomplish the foregoing objects; to secure, hold and disburse endowments to insure the continuity of its operations and perpetuate its objects, and all things incidental to the foregoing.

FOURTH. The following persons shall serve said corporation as trustees until the first annual meeting or other meeting called to elect trustees:

Henry C. Kloepfer	Standard Brick & Tile Corp.	Evansville, Indiana
Edward H. Kraus	Chanters Brothers Co.	Philadelphia, Pennsylvania
O. F. Lockett	New Crawfordsville Shale Brick Co.	Crawfordsville, Indiana
John P. Martin	Building-Brownell Corp.	New Straitsville, Ohio
Anco P. Potts	Clay Products Co.	Brazil, Indiana
Evan Rodgers	Alton Brick Co.	Alton, Illinois
Douglas P. Stevens	Acme Brick Co.	Danville, Illinois
C. Forrest Toffy	Claycraft Mining & Brick Co.	Columbus, Ohio
J. Ottis Wilson	Alliance Clay Product Co.	Alliance, Ohio

IN WITNESS WHEREOF, We have hereunto subscribed our names this 10th day of June, 19 31

Henry C. Kloepfer — John P. Martin — Douglas P. Stevens

Edward H. Kraus — Anco P. Potts — C. Forrest Toffy

O. F. Lockett — Evan Rodgers — J. Ottis Wilson

Illinois
THE STATE OF OHIO, COUNTY OF Vermilion, ss.

Personally appeared before me, the undersigned, a Notary Public in and for said county, this 10th day of June, 19 31, the above named Henry C. Kloepfer, Edward H. Kraus, O.F. Lockett and John P. Martin, Anco P. Potts, Evan Rodgers, Douglas P. Stevens, C. Forrest Toffy, J. Ottis Wilson, who each severally acknowledged the signing of the foregoing articles of incorporation to be his free act and deed, for the uses and purposes therein mentioned.

SEAL

Ethel M. King
Notary Public
Vermilion County, State of Illinois

United States of America
STATE OF OHIO
Office of the Secretary of State

I, Clarence J. Brown, Secretary of State, of the State of Ohio, do hereby certify that the foregoing is an exemplified copy, carefully compared by me with the original record now in my official custody as Secretary of State, and found to be true and correct, of the Articles of Incorporation of NATIONAL BRICK MANUFACTURERS RESEARCH FOUNDATION

filed in this office on the 14th day of July, 19 31, and recorded in Volume 399, Page 136, of the Records of Incorporations.

WITNESS my hand and official seal at Columbus, Ohio, this 14th day of July, 19 31

Secretary of State.

FIG. 1.—Articles of Incorporation of National Brick Manufacturers Research Foundation.

NEW MEMBERS RECEIVED IN AUGUST

CORPORATION

Alabama Clay Products Co., A. J. Holberg (voter), 833–37 Martin Bldg., Birmingham, Ala.

Western Brick Co., F. M. Butterworth (voter), Danville, Ill.

PERSONAL

Felix Edgar Wormser, Secretary-Treasurer, Lead Industries Assn., Graybar Bldg., New York, N. Y.

Membership Workers' Record

CORPORATION: Office 2. PERSONAL: C. H. Peddrick, Jr. 1.

ROSTER CHANGES IN AUGUST

CORPORATION*

Republic Steel Corp., F. M. Portz (voter), Massillon, Ohio. (Name changed from Central Alloy Steel Corp.)

PERSONAL*

Brannon, W. F., Brooks Field, San Antonio, Texas. (Leeds & Northrup Co., Philadelphia, Pa.)

Burr, Marion K., Chas. Taylor Sons Co., Taylor, Ky. (McCall, Ky.)

Butler, Matthew W., 221 East Sheridan Ave., New Castle, Pa.; Westmoreland Products Co. (692 East 115th St., Cleveland, Ohio.)

Given, Conrad W., Michigan Steel Corp., Detroit, Mich. (Ecorse, Mich.)

Haldeman, Virgil K., 330 Whittley Ave., Avalon, Catalina Island, Calif. (Hollydale, Calif.)

Harvey, Edwin T., Goldfield, Iowa. (Y. M. C. A., Joliet, Ill.)

Hunt, M. H., Porcelain Products, Inc., Parkersburg, W. Va. (Westinghouse Electric & Mfg. Co., Derry, Pa.)

Husain, Tajamul, 170 Chittenden Ave., Columbus, Ohio. (Roseville, Ohio.)

Kempf, W. C., 888 De Graw Ave., Newark, N. J. (66 College Ave., New Brunswick, N. J.)

Kennaday, Clinton R., 557 Maple Ave., Woodbridge, N. J. (32 Graham Ave., Metuchen, N. J.)

Kirk, Leander R., Governor Dummer Academy, South Byfield, Mass. (Universal Sanitary Mfg. Co., New Castle, Pa.)

Kirkpatrick, F. A., Apt. 301R, 6234 Chestnut St., Philadelphia, Pa. (Unionville, Mich.)

Kleerup, N. O. Alex, 21 South Park St., Western Asbestos Magnesia Co., San Francisco, Calif. (2708 Channing Way, Berkeley, Calif.)

Krieg, William H., 530 W. Riverside Drive, Kohler, Wis. (This is a correction on the change of address on page 260 of the July *Bulletin*.)

Luks, Daniel W., Frenchtown, N. J. (12 Carroll St., Trenton, N. J.)

Lumley, John H., Northwestern Terra Cotta Co., 2525 Clybourn Ave., Chicago, Ill. (Denver, Colo.)

Messimer, LaVerne A., Cement Reference Laboratory, Bureau of Standards, Washington, D. C. (15 Howard St., Manchester, N. Y.)

Mitchell, Lane, 157 Baker St. N.W., Atlanta, Ga. (111 Ceramics Bldg., University of Illinois, Urbana, Ill.)

Moncrieff, James W., 310 W. Broad St., Columbus, Ohio; Harrop Ceramic Service Co. (Newell, W. Va.)

Oravec, Joseph A., 4726 North Kenton Ave., Chicago, Ill. (237 N. Dithridge St., Pittsburgh, Pa.)

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*Addresses within the parentheses represent the old addresses.

These roster changes which are published each month may be checked against the complete Membership Roster which appeared in the July, 1929, issue of the *Bulletin*. Copies of this issue may be obtained from the Secretary's office, price $2.00.

Petrie, Earl C., 925 Clarissa St., Pittsburgh, Pa. (Cheswick, Pa.)
Richardson, Gordon B., W. S. Dickey Clay Mfg. Co., 116 New Montgomery St., San Francisco, Calif. (Livermore, Calif.)
Ruprecht, Bertram C., 546 Miffin Ave., Wilkinsburg, Pa. (122 Whitfield St., Pittsburgh, Pa.)
Spurrier, H., c/o Wm. Carruthers, Lathrup Townsite, Birmingham, Mich. (4512 Malden Ave., Chicago, Ill.)
Taylor, Chas. H., Chas. Taylor Sons Co., Taylor, Kentucky. (McCall, Ky.)
Thornton, Paul E., 47 Hubbard Ave., Mt. Clemens, Mich. (428 Argyle St., Waterloo, Iowa.)
Turner, Drury D., 2704 4th St., N.W., Canton, Ohio. (2801 Preble Ave., Pittsburgh, Pa.)
Walker, Thomas, Lalux Clay Co., Alamogordo, New Mexico. (1234 S. Orange St., Glendale, Calif.)
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Weis, J. H., United Feldspar Corp., 10 E. 40th St., New York, N. Y. (Northville, N. Y.)
Westmont, O. B., 1060 Park Ave., Schenectady, N. Y. (Lompoc, Calif.)
Wheeler, D. D., 314 West 5th, Erie, Pa. (2141 University Ave., Morgantown, W. Va.)
Wilde, John F., Catalina Clay Products, Avalon, Catalina, Calif. (635 N. Main St., Pomona, Calif.

NECROLOGY

W. E. Wells

Mr. W. E. Wells, Chairman of the Board of Directors of the Homer Laughlin China Company, Newell, W. Va., died suddenly Friday, September 18, 1931.

An outline of Mr. Wells' active career is given as follows:

(1) Born in 1863 in Brooke County, W. Va., a farmer boy.

(2) Educated in the Steubenville public schools.

(3) Answered advertisement for bookkeeper at Homer Laughlin in 1889.

(4) Was made manager of the Homer Laughlin China Company in 1896 when the Laughlin interests were purchased by the Aaron Brothers of Pittsburgh.

(5) Built the plant capacity up to twenty-five times that which the Company had when he became manager.

(6) Resigned as Secretary and General Manager in 1930 and was made Chairman of the Board of Directors.

(7) At the time of his death, Mr. Wells was President of the Potters' National Bank and director in six business corporations other than the Homer Laughlin China Company.

(8) Was a leader in many civic enterprises, member of the Board of Education, a generous contributor to hospitals, schools, and religious institutions, and a leader in community activities during the war.

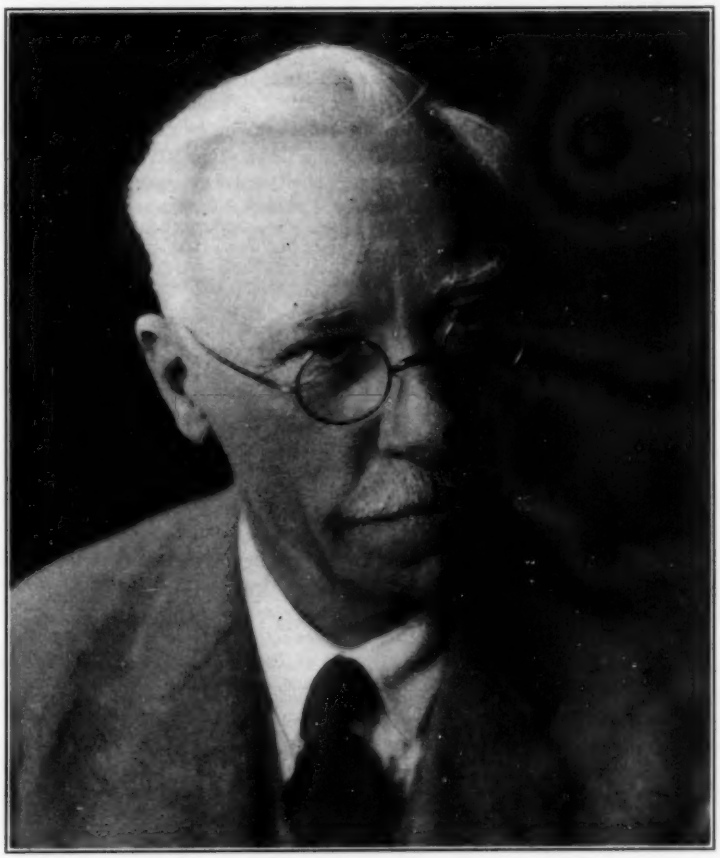
(9) Served as president of the U. S. Potters' Association and for several years as chairman of the wage and tariff committees of that Association.

(10) A self-taught scholar, learned in literature, an excellent orator, a humanistic philanthropist, a booster for such coöperative enterprises as the AMERICAN CERAMIC SOCIETY, Mr. Wells naturally found many ways for leadership in civic, national, industrial, educational, and religious affairs. He did not live alone to himself and for himself but gave generously of his talents and of his substance.

(11) The building of the world's largest pottery, marked achievements in local and national affairs, a director in varied human affairs are only indicative marks of his business genius and unusual keenness in organized affairs. These material achievements

do not reveal the cultured man whose leadership was not by might but by love and appreciative interest in the welfare of those with whom he came into contact, the rich and the poor, the lowly and the favored, the young and the aged.

The true greatness of Mr. Wells was reflected in the large number of people of all



W. E. WELLS

walks and stations in life who lined the streets in respectful attention as the cortège passed from his home to the cemetery. These people were indeed impressive symbols of sympathy and respect for this man who had been their generous leader in so many affairs that concerned their well being, both individually and in the community in which they live.

The AMERICAN CERAMIC SOCIETY lost a valuable, staunch, and inspiring member

when W. E. Wells passed away. His three sons, all members of the SOCIETY, will carry on with the many interests to which their father gave attention, but, each one of us has a larger responsibility put upon us because W. E. Wells will no longer be with us with his distinctively intelligent and inspiring leadership.

B. F. Drakenfeld, Jr.

Mr. B. F. Drakenfeld, Jr., President of B. F. Drakenfeld & Co., Inc., died at his home in New York City on September 4 after a short illness.

Mr. Drakenfeld was born in California in 1878. His education included study at a number of technical schools in Germany as well as in the United States. In 1898 he joined his father's company and in 1913, following the death of his father, he became the active head of the firm and continued in that capacity until the time of his death.

Mr. Drakenfeld had been a member of the AMERICAN CERAMIC SOCIETY since 1917 and his death will be a great loss to his associates in the ceramic industries.

NOTES AND NEWS

PUBLICITY FOR AMERICAN POTTERY

2525 N. High Street,
Columbus, Ohio
September 3, 1931

To the United States Potters:

It has been amazing to learn that the potters of America are submitting to what has been presented as public opinion to the effect that American pottery is inferior to that which is produced abroad.

We know that the American tableware product is for the most part superior. The Lenox Belleek and the vitrified china have no reason for not outranking the pottery product of all other nations in the people's estimation, as in fact they do.

A large part of the earthenware made in America compares favorably with the earthenware made in any of the other countries.

There is no reason why American pottery should not have the respect of the purchasing public, the buyers, and the distributors. It is nonsensical for anyone engaged in pottery manufacture in America not to hold his product in fact, in word, and in deed to be the equal or the superior of any produced elsewhere.

It is going to take a great deal of publicity to educate the purchasing public. There must be developed a willingness on the part of the public to pay as much for excellent American ware as it is now paying for foreign ware.

As one of the publicity stunts, I suggest that the potters collaborate with the program committees of the womens' clubs in the formulation and the staging of programs devoted to American tableware potteries.

Attached is a sample program which was devised by Mrs. Dixon of Burlington, Iowa, with the assistance of Professor Paul E. Cox, Director of the Ceramics Department, Iowa State College, Ames, Iowa.

ROSS C. PURDY,
General Secretary

Program for Club Study, "American Pottery and Porcelain"

PREPARED BY MRS. ANNA LANE DIXON

(1) Colonial usage of pewter and woodenware. Colonial brickmaking in New England, New Jersey, Pennsylvania, and Virginia. Colonial tile-making in the Dutch colonies. Original delftware and the use of tin glaze.

(2) Differences between porcelain and pottery. Composition of porcelain: soft paste, hard paste. Study of terms: stone china, ironstone, bone china, semiporcelain, vitreous, faience. Salt glaze, lead glaze, application of glaze. Bright, mat, and crackle glazes.

(3) Rise of porcelain: Chinese, Japanese, Italian, German, French, English. Timothy Dwight, potteries at Stoke-on-Trent.

(4) Meissen. Sèvres. Wedgwood's visit to the clay deposits of the Carolinas.

(5) Indian pottery.

(6) Early New York and Pennsylvania ware: slip, spatter, and sgraffito decor. Tulipware. Mountain pottery: Unaka, Bybee, Cole.

(7) Early importations of china: blue-and-white ware. Willow ware and the story of Thomas Minton. Spode, Lowestoft, Bow, Chelsea, Luster. Influence of jewelers' art upon form and decoration of china.

(8) Early American potteries: Burlington, N. J. Southwark Pottery, Bonnin & Morris. Fulper. Tucker China, Philadelphia. U. S. Government attitude then and now: Tariff Acts 1922 and 1930. Ceramics Department at Ames, Iowa.

(9) Bennington Pottery: historical china, plates, pitchers, etc.; Clewes. China of the White House to 1920.

(10) Kitchenware: Rockingham, yellow, Morton. Tableware today: Onondaga Pottery, Syracuse, N. Y. Edwin Knowles, East Liverpool, Ohio, or any other standard ware made in Ohio. For study in contrast, both body and glaze, of American ware with tableware of foreign manufacture, English: Wood, Copeland, Wedgwood, Cauldon. French: Haviland. German: Rosenthal or any good Bavarian.

(11) Belleek: Irish. American: Coxon, Wooster, Ohio; Morgan, Canton, Ohio; Lenox, Trenton, N. J. The story of Lenox: present-day white china. Lenox reproduction of Washington-Wakefield pattern. The Washington-Wakefield Memorial Assn.

(12) Manufacturing processes, ancient and modern. Modern associated industries, such as tile, brick, terra cotta, plumbers', druggists' and hospital supplies, bakelite, electrical and radio fixtures, fleuron, enamelware, etc. (This entire number should be given by an expert.)

(13) The story of (1) Rookwood, (2) Newcomb, (3) Van Briggle. Club to bring examples of each and discuss characteristics.

(14) Other American art ware, such as Roseville, Zane, Brush, Weller, and Cowan, all from Ohio; Niloak, Benton, Arkansas; Western Stoneware, Monmouth, Ill. Ask for loan exhibit from private homes and local dealers.

(15) A Cup of Tea (Social occasion):

(*a*) The story of tea, manufacture of cup, cup-plate, saucer, and cup with handle.

(*b*) Early American glass, an attractive correlative subject if desired. Display of American-made cups, saucers, teapots, etc., antique and modern.

CALENDAR OF MEETINGS

Organization	Date	Place
American Assn. for the Advancement of Science	December 28, 1931 to January 2, 1932	New Orleans, La.
AMERICAN CERAMIC SOCIETY	February 7–13, 1932	Washington, D. C.
American Engineering Council	October 30–31	Washington, D. C.
Annual Meeting	January 14–16, 1932	Washington, D. C.
American Face Brick Assn.	November 4–6	West Baden, Ind.

American Gas Assn.	October 12–18	Atlantic City, N. J.
American Institute of Chemical Engineers	December 9–11	Atlantic City, N. J.
Common Brick Mfrs. of America	February 1–6, 1932	Louisville, Ky.
Electrochemical Society	April 21–23, 1932	Baltimore, Md.
Gypsum Assn.	December 9	Chicago, Ill.
National Assn. of Manufacturers	October 5–9	New York, N. Y.
National Assn. of Manufacturers of Pressed and Blown Glassware	March 8, 1932	Pittsburgh, Pa.
National Exposition of Power and Mechanical Engineering	December 5–10	New York, N. Y.
National Glass Distributors Assn.	December 1–3	Pittsburgh, Pa.
National Safety Council	October 12–16	Chicago, Ill.
New Jersey Clay Workers Assn.	October	Trenton, N. J.
Ohio Ceramic Industries Assn.	November 6–7	Columbus, Ohio
Optical Society of America	October 22–24	Rochester, N. Y.
Sand-Lime Brick Assn.	February 3–4, 1932	Washington, D. C.
Scientific Apparatus Makers of America	May, 1932	Wernersville, Pa.
Structural Clay Tile Assn.	February 17–19, 1932	Chicago, Ill.
Taylor Society, Inc.	December 2–4	New York, N. Y.
Tile & Mantel Contractors' Assn. of America, Inc.	February 9–12, 1932	Rochester, N. Y.

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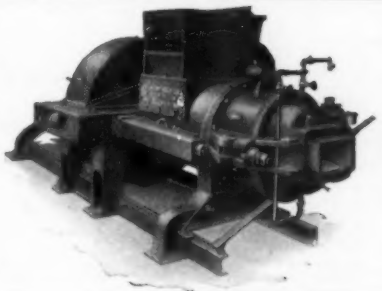

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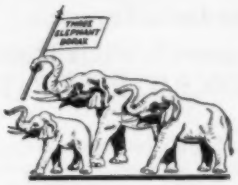

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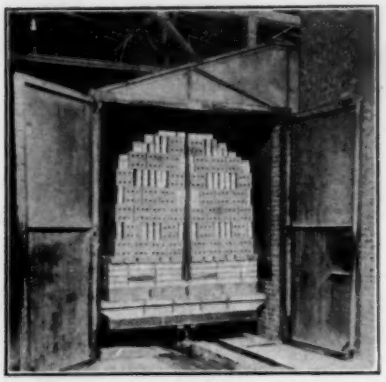

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